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The Ever Varied Blood Supply of the Liver and Its Collateral Circulation

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THIS contribution is based on a dissection and statistical analysis of 200 cadavers in the anatomic dissecting rooms. In each instance I personally dissected the arteries supplying the upper abdominal organs and made sketches of them prior to manipulation of them by students. The final details of terminal ramifications of the regional arteries, especially of the hepatic and cystic arteries, were worked out in excised specimens, these comprising in all instances, *en bloc*, all of the supramesocolonic organs. To avoid preconceived categorization the difficult, at times baffling, statistical estimates were made only after all sketches had been completed. Of the 200 bodies statistically analyzed, 181 were male and 19 female. The ages varied from 25 to 90 years, the majority being over 50 years.

Terminology.—In reading previous investigations of the hepatic blood supply, one is impressed with the looseness and nonuniformity of meaning with which the term "accessory hepatic artery" has been used. Most authors have failed to state whether the accessory is really an accessory or whether it is a replaced hepatic artery, i. e., one taking the place of the normal hepatic and arising from a source other than the celiac. Percentages as re-

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gards accessory hepatics have little significance and meaning unless it is definitely stated what kind of hepatic artery is meant by the term "accessory." To clarify this situation, the following nomenclature of the hepatic artery is used:

A typical "normal" hepatic artery arises from the celiac artery and divides into three main branches, right hepatic, left hepatic and middle hepatic, the last-mentioned supplying the quadrate lobe. The middle hepatic is usually a branch of the right or left hepatic and arises in about equal proportion (45 per cent) from either stem. Despite its early description by Haller in 1756 it is not described in texts of anatomy or surgery, domestic or foreign. In view of its constancy and the fact that in some instances it gives rise to a cystic artery, *the middle hepatic should be included in all texts.*

When a hepatic artery arises from a source other than the terminal end of the celiac trunk, it is considered an aberrant hepatic, of which there are two types, replaced and accessory. A replaced hepatic is a substitute for the normal celiac hepatic which is lacking; an accessory hepatic is additive to the celiac hepatic normally present.

The term supraduodenal designates the artery of Wilkie that supplies the upper border and the anterior and posterior surfaces of the first inch of the duodenum, the area corresponding roughly to the anemic spot of Mayo. In some instances it arises from the right hepatic or cystic. The term "retroduodenal" denotes the artery that forms a scalloped arcade on the back of the head of the pancreas, with branches to the entire posterior surface of the duodenum. It is synonymous with the cumbersome and confusing term—the posterior superior pancreaticoduodenal—which was applied to this textually unlisted artery by Belou and by Petrén, and was subsequently used by Pierson and by Woodburne and Olsen to distinguish it from the superior pancreaticoduodenal, anterior in position and well known to surgeons. As will be shown later, and has been substantiated by Appleby of Canada, the retroduodenal is one of the main arteries supplying the common duct.

The dorsal pancreatic is a textually unlisted artery that supplies the back of the pancreas in the cervical region. It can readily be found behind the juncture point of the superior mesenteric vein and the splenic vein. The transverse pancreatic is an unlisted artery that courses along the inferior surface of the pancreas, at the tail end of which it anastomoses with a branch of the splenic. The dorsal pancreatic and transverse pancreatic are important routes of collateral circulation to the liver, as will be shown later.

The Celiac Artery.—The conventional textbook description of the arterial blood supply of the liver, effected through a celiac trunk having three branches (hepatic, left gastric and splenic) *occurs only in about one-half of the population (55 per cent of 200 bodies), while that of the gallbladder (by a single cystic from a celiacal right hepatic in the cystic triangle of Calot) occurs only in 63 per cent.* The main causes of this amazing deviation from the so-called "normal" are the varied anatomic disposition of the celiac artery and the varied sites of origin of the right and left hepatics, be these accessory or replaced. When typical and complete the celiac artery has three branches, the left gastric, the splenic (lienal) and the hepatic artery constituting a complete hepatolienogastric trunk (65 per cent of 200 bodies). This trunk may be incomplete when the right, middle or left hepatic artery arises from some other source, thereby constituting an incomplete hepatolienogastric trunk. Hence, in complete or incomplete form, a hepatolienogastric trunk occurs approximately in 90 per cent,

all other types of celiac trunks comprising the remaining 10 per cent. The celiac may omit the left gastric, forming a hepatolienal trunk (3.5 per cent) or the hepatic, forming a lienogastric trunk (5.5 per cent), or the splenic, forming a hepatogastric trunk (1.5 per cent).

Additive branches of the celiac artery comprise the dorsal pancreatic (22 per cent), the inferior phrenics (74 per cent) and the middle colic or an accessory middle colic (3 cases). Frequently, the celiac hepatic is absent. In this series of 200 bodies the common hepatic artery was replaced from the superior mesenteric in five bodies, from the aorta in 3 and the left gastric in 1. The tripod of Haller occurred in 25 per cent. A tetrapod, formed by addition of the dorsal pancreatic, was observed in 5 per cent.

Aberrant Hepatic Arteries.—An aberrant hepatic artery arises otherwise than from a typical celiac hepatic. Aberrant hepatics comprise two types, viz., replaced and accessory, the former being substituted and the latter additive vessels. Whether replaced or accessory, every hepatic artery supplies a definite region of the liver, as was proved by Healey and Schroy (1953) in their 100 plastic corrosion casts of human livers.

Replaced right hepatics take origin predominantly from the superior mesenteric artery and, less seldom, from the aorta or the gastroduodenal, retroduodenal, superficial cystic or dorsal pancreatic arteries. Replaced left hepatics arise, nearly exclusively, from the left gastric artery or from the superior mesenteric via a replaced hepatic trunk (5 cases). Accessory hepatics take origin from various sources; accessory right hepatics arise predominantly from the superior mesenteric, accessory left hepatics from the left gastric.

Of the 200 bodies statistically investigated, 83 (41.5 per cent) had one or more aberrant hepatics, while 117 (58.5 per cent) had none. In all, 106 aberrant hepatics were observed in the 83 bodies having them. Sixty-three (31.5 per cent) had one (accounting for 63); 17 (8.5 per cent) had 2 (accounting for 34) and 3 (1.5 per cent) had 3 (accounting for 9). Failure of authors to differentiate between the total number of aberrant hepatics observed in the sample they have investigated and the number of bodies actually having such an aberrant hepatic accounts for the marked differences in the percentages of aberrant and accessory right hepatics recorded in the literature. The present statistical analysis warrants the conclusion that some sort of an aberrant hepatic artery (replaced or accessory) occurs approximately in every other human body (41.5 per cent) and that 31.5 per cent have but one aberrant hepatic artery, while 10 per cent have two or more.

Because of the frequent origin of the left hepatic artery (replaced or accessory) from the left gastric, the early anatomists followed the nomenclature that Haller suggested in 1745 and designated the left gastric as the *gastrohepatic artery*, a term still used in current French texts. Of the 46 bodies having an aberrant left hepatic arising from the left gastric, 23 such arteries were replaced and 23 were accessory. Hence, functionally considered, *one-half of the aberrant left hepatics from the left gastric constitute the only left hepatic present. Severance of such a left hepatic during gastric resection will lead to ischemia and subsequent fatal necrosis of the left lobe of the liver* (seventh day, Hofmeister; sixteenth day, Wilmer; Guibé and Herrenschmidt; Klose; Holst).

Of the 34 bodies having an aberrant right hepatic from the superior mesenteric artery, 25 were replaced and only 9 were accessory. Accordingly, about three-fourths of the aberrant right hepatics arising from the superior mesenteric (17 per cent incidence, including replaced he-

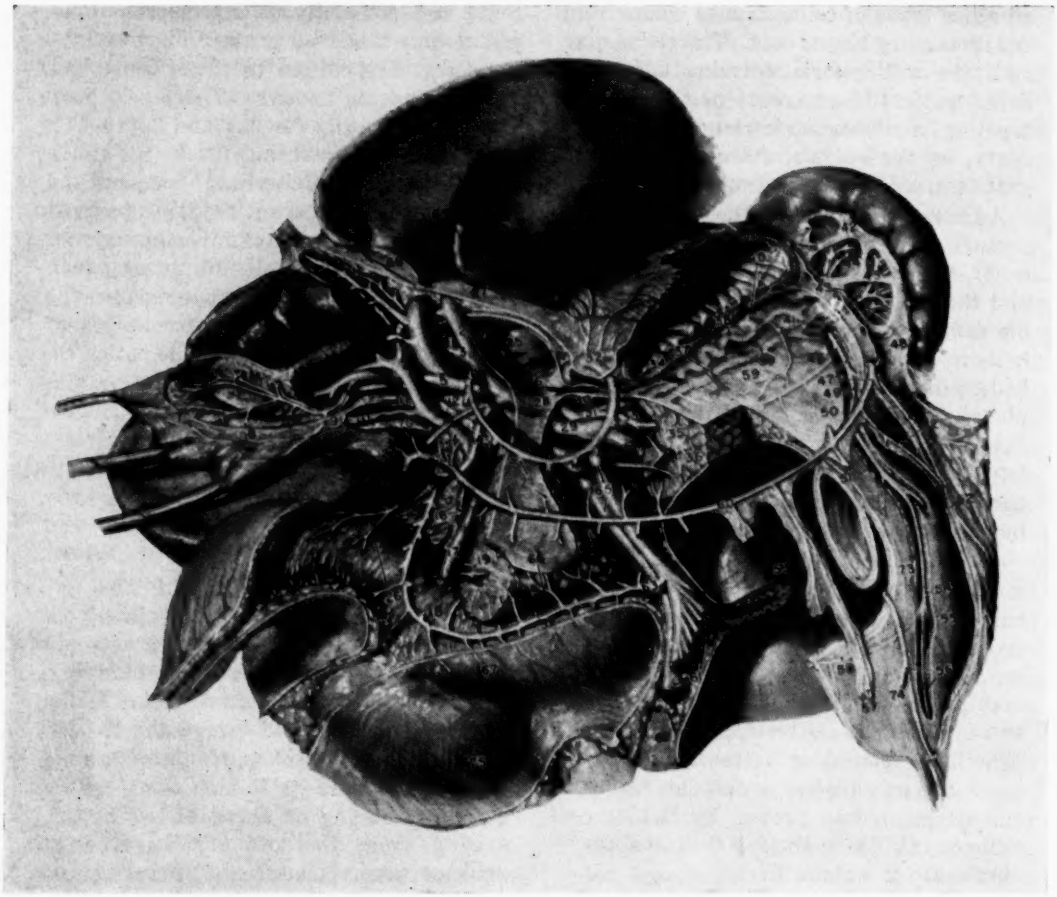

Fig. 1.—Typical blood supply of the upper abdominal organs. In this illustration, the various depths at which the structures and recesses actually lie and in which the arteries course are shown in proper perspective. Drawing was made by W. B. McNett, a pupil of Brödel, using the author's pencil sketch as a guide.

The celiac arterial pattern presented, i.e., that of a celiac artery giving rise to the common hepatic, splenic and left gastric arteries, *occurs only in about one-half of the population* (*55 per cent*); in the other half markedly different variations exist. Typically, the common hepatic artery divides into a right (*5*), left (*2*) and middle hepatic (*3*), the latter supplying the quadrate lobe or the medial segment of the left lobe (*6*). The single cystic artery (*9*) arises in Calot's triangle and divides into its superficial branch (*8*) and the deep branch (*7*).

The cystic triangle of Calot (*11*) is formed by the angular union of the cystic duct (*10*) with the hepatic duct (*4*). The latter receives three ducts which, according to the plastic casts of Healey and Schroy, most probably represent a right duct for the anterior and posterior segment of the right lobe, a medial segment duct for the medial segment and a lateral segment duct for the lateral segment of the left lobe.

The right hepatic artery (*5*) divides into its anterior and posterior segmental branch for the respective segments of the right lobe. The left hepatic (*2*) divides into its superior and inferior area branch of the lateral segment of the left lobe. The middle hepatic (*3*) supplies the medial segment of the left lobe. These statements are in accord with observations on the 150 vinyl plastic casts of human livers made by Healey and Schroy (the latter a graduate student under the supervision of the author) at the Daniel Baugh Institute of Anatomy.

The supragastric circle made by the right (*20*) and left (*32*) gastric and the infragastric circle

patic trunks) are replaced, i.e., *the only right hepatic present.* The inexcusable ligation of such an artery during cholecystectomy deprives the right lobe of its blood supply and may readily be the direct cause of grave morbidity and death, as was forcefully emphasized by the British surgeon Gordon-Taylor. Severance of a common hepatic artery of superior mesenteric origin (5 cases) during pancreaticoduodenal resection, of a common hepatic of superior mesenteric origin (5 cases) during pancreaticoduodenal resections or of a common hepatic trunk arising directly from the left gastric artery (1 case), would result in immediate death of the patient.

Despite the complexity and varied character of the hepatic arterial blood supply, any sample of it may, with minor modifications, be categorized into one of the following ten basic types:

The celiac hepatic artery supplies:

1. The right, left, and middle hepatic (textbook type and present only in about half (55 per cent) of the subjects (Fig. 2*A*).
2. The right and middle hepatic—the left hepatic replaced from the left gastric; 10 per cent (Fig. 2*B*).
3. The left hepatic and middle hepatic —the right hepatic replaced from the superior mesenteric; 11 per cent (Fig. 2*C*).
4. Only the middle hepatic—the right hepatic replaced from the superior mesenteric, the left hepatic replaced from the left gastric; 1 per cent.
5. The right, middle and left hepatic —left hepatic small, hence an accessory left hepatic from the left gastric; 8 per cent (Fig. 2*D*).
6. The right, middle and left hepatic —right hepatic small, hence an accessory right hepatic from the superior mesenteric, etc.; 7 per cent (Fig. 3*A*).

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made by the right (*13*) and left (*47*) gastroepiploic arteries are shown. About the head of the pancreas are an anterior and a posterior pancreaticoduodenal arcade made respectively by the superior pancreaticoduodenal (*18*) and the *retroduodenal* (posterior superior pancreaticoduodenal) artery (*16*). Both arcades join the superior mesenteric artery (*65*) via a common inferior pancreaticoduodenal (*63*). The artery of Wilkie (*15*) to the first part of the duodenum has had a section of it removed. The splenic artery (*38*) is characteristically tortuous and distally gives off a superior polar artery (*40*) to the spleen before dividing into its superior and inferior terminal branches.

Near the juncture point of the splenic vein (*39*) with the superior mesenteric vein (*65*) is the *dorsal pancreatic artery* (*33*). After supplying the neck region of the pancreas it gives off the *transverse pancreatic artery* (*35*) which courses along the inferior surface of the pancreas, at the tail end of which it anastomoses with the a. pancreatic magna (*41*) of the splenic and with the a. caudae pancreatis (*46*) from the left gastroepiploic (*47*). To the right it anastomoses with the superior mesenteric (*65*).

The anterior and posterior walls (*52*) of the inferior recess (*55*) of the omental bursa in the great omentum are shown. Situated in the posterior wall of the great omentum below the transverse colon (*51*) is the large *epiploic arc of Barkow* (*58*), the left limb of which is made by the left epiploic (*54*) from the left gastroepiploic (*47*). The right limb is not shown but is made by the right epiploic from the right gastroepiploic (*13*). Descending branches or anterior epiploic arteries (*72*) from the infragastric arterial circle end in the arc, as do some of the descending branches or posterior epiploic arteries (*73*) given off by the transverse pancreatic (*35*) coursing in the pancreas. The arc gives an additive blood supply to the transverse colon (*51*).

The *retroduodenal artery* (*16*) after its origin from the gastroduodenal (*14*) swerves around the common bile duct (*17*), supplying it and the ampulla of Vater in its course. The retroduodenal arcade with its branches to the back of the duodenum (*26*), here turned forward, is faintly visible behind the head of the pancreas.

A portion of the body of the pancreas (*36*), as well as a portion of its head (*71*) have been cut away. At the latter site is shown the union of the pancreatic duct (*19*) with the common bile duct (*17*). The major part of the stomach has been removed to show the retrogastric space of the omental bursa (*34*), bounded dorsally by the pancreas. The foramen of Winslow (*23*) leads into the vestibule of the omental bursa (*24*), where is visible the caudate lobe of the liver (*25*). Relations of the portal vein (*12*) to the hepatic arteries and bile ducts are shown, including the tributaries arising in the umbilical fossa (*1*).

7. The right, left and middle hepatic —small or of usual size. There is an accessory right hepatic from the superior mesenteric and an accessory left hepatic from the left gastric; 1 per cent (Fig. 3*B*).
8. Combination patterns of a replaced right hepatic and an accessory left hepatic or, the reverse of this, an accessory right hepatic with a replaced left hepatic; 2 per cent.
9. Celiac hepatic absent — the entire hepatic trunk derived from the superior mesenteric; 5 cases.
10. Celiac hepatic absent — the entire hepatic trunk derived from the left gastric; 1 case (Fig. 3*D*).

The Cystic Artery.—Typically, the cystic artery arises from the celiac right hepatic to the right of the hepatic duct in Calot's triangle, the boundaries of which are: inferolaterally, the cystic duct; medially, the hepatic duct, and cephalad, the liver. As a rule, the right hepatic and the cystic artery are located in the upper part of the triangle, the right hepatic having crossed under or over (12 per cent) the hepatic duct to reach the triangle. If, in any subject, the surgeon is in doubt as regards the identity of structures, a careful dissection or creation of this triangle will, in most instances, effect correct orientation.

The course of the cystic artery in the

Fig. 2.—*A*, typical pattern. The hepatic artery divides into a left, middle and right branch, the middle supplying the quadrate lobe. Two cystic arteries, the superficial (*SC*) distributed to the peritoneal (free) surface, the deep (*DC*) to the nonperitoneal attached surface of the gallbladder and underlying liver substance. The cystic duct (*CD*), 6 cm., after a long, nearly parallel course with the hepatic duct (*HD*), swerves posterior to it to open into the common bile duct (*CBD*) just above the duodenum. The supraduodenal artery of Wilkie (*SD*) is distributed to the upper anterior and posterior surfaces of the first part of the duodenum. The *retroduodenal* (*RD*) (posterior superior pancreaticoduodenal) forms an extensive arcade on the posterior surface of the duodenum and head of the pancreas, then joins a posterior branch of the common inferior pancreaticoduodenal (*CIPD*). The *dorsal pancreatic* (*DP*) at junction of splenic vein with superior mesenteric is distributed to, and courses downward along, the dorsal surface of the neck of the pancreas; its prominent left branch, the transverse pancreatic (*TP*), runs along the inferior surface of the pancreas where it ultimately unites with a terminal branch of the splenic; its smaller right branch joins the superior pancreaticoduodenal (*SPD*); another branch supplies the uncinate process of the pancreas. *B*, type with a replaced left hepatic artery (*ReLH*), as the celiacal hepatic here gives origin only to the right (*RH*) and the middle hepatic (*MH*). The artery supplying the left lobe of the liver is *not an accessory hepatic.* as commonly stated, but is the only left hepatic present being replaced by the left gastric (*LG*). The *supraduodenal* (*SD*) is a branch of the right hepatic (*RH*). The *dorsal pancreatic* (*DP*), instead of coming from the celiacal trunk or one of its branches (first part of splenic or hepatic), arises from the superior mesenteric (*SM*). The cystic artery (*C*) is double, for, as often is the case, its superficial and deep branch have separate origins. Interposed between them is a liver artery (*RIL*), most probably the posterior segmental branch of the right lobe, as judged from the liver casts of Healey and Schroy. Note the accessory hepatic duct (*AcHD*) near the deep cystic artery (*DC*). *C*, type with a replaced right hepatic (*ReRH*), as the celiac hepatic gives rise only to the gastroduodenal and left hepatic. The right and quadrate lobes of the liver are supplied by a branch from the superior mesenteric (*SM*). This branch is not, as commonly stated, an accessory right hepatic, but is a *replaced right hepatic* (*ReRH*). The cystic artery (*C*) here lies high; below it are the posterior segmental branch of the right lobe (*RIL*) entering the fissured area under the gallbladder and a large (4 mm.) accessory hepatic duct (*AcHD*) which runs close to and parallel with the cystic duct (*CD*). Emerging from the gallbladder bed is another accessory hepatic duct (*Ac. HD*), known as the *subvesical duct* which may readily be torn in a cholecystectomy when filamentous, as is often the case. *D*, type with an accessory left (*AcLH*). The celiac hepatic gives off its characteristic three branches, right, middle and left. Since the celiacal left hepatic is small, there is an accessory left hepatic (*AcLH*) from the left gastric, it *being accessory only in origin as it supplies a definite section of the left lobe.* The right hepatic is ventral to the common hepatic duct (10 to 20 per cent). The deep cystic (*DC*) takes origin from a looped section (caterpillar loop) of the right hepatic above the cystic duct and to the right of the hepatic duct. The superficial cystic (*SC*) arises from gastroduodenal via its *retroduodenal* (*RD*) *branch* to the left of the hepatic duct (*HD*), and courses *caudad to the cystic duct* (*CD*). Note in particular how the blood supply of the posterior surface of the duodenum via the retroduodenal artery (*RD*) may be tied up with that of the gallbladder. The cystic duct (*CD*) swerves to the posterior surface of the hepatic duct (*HD*), with which it is intimately united with connective tissue. The dorsal pancreatic (*DP*) arises from the superior mesenteric (*SM*) and has the common inferior pancreaticoduodenal (*CIPD*) branch.

triangle may be short or long, depending on its site and mode of origin. On reaching the gallbladder it usually bifurcates into its characteristic superficial and deep branch — the *cysticae gemellae* spoken of by Vesalius in 1564. The superficial branch is distributed to the free, peritoneal surface of the gallbladder; the deep branch courses behind the gallbladder and is distributed to its attached, nonperitoneal surface and to the gallbladder bed.

The superficial and deep cystic branches are anastomosed at various points on the gallbladder, and both emit a variable number of twigs to the liver substance, sometimes more to the right than to the left side of the gallbladder or vice versa. Quite frequently such twigs are no longer twigs, but *liver vessels* of appreciable size. A few cases were encountered in which, respectively considered, the superficial, the deep or both cystic branches, after supplying the gallbladder, entered the liver as major liver arteries, as a dissection of them revealed.

Double Cystic Artery: In about one-fourth of the population the superficial and deep branches of the cystic arteries have a separate origin. In a common pattern the deep cystic arises from the right hepatic in the triangle, the superficial from the right hepatic to the left of the hepatic

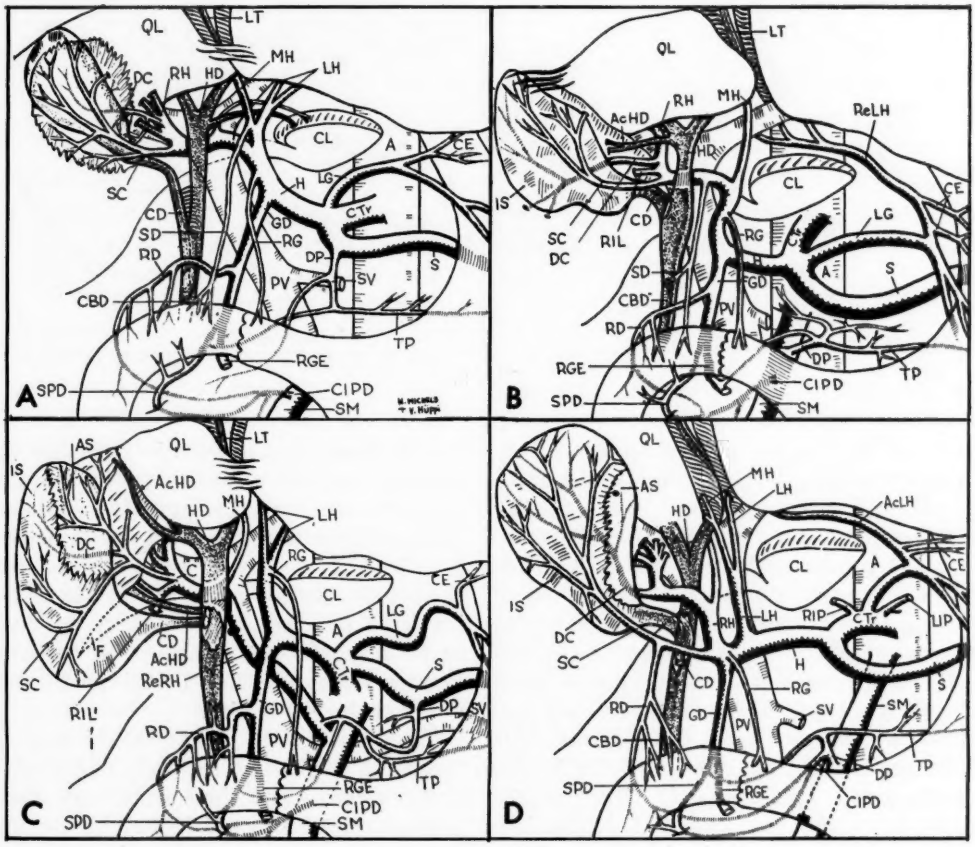

Fig. 2

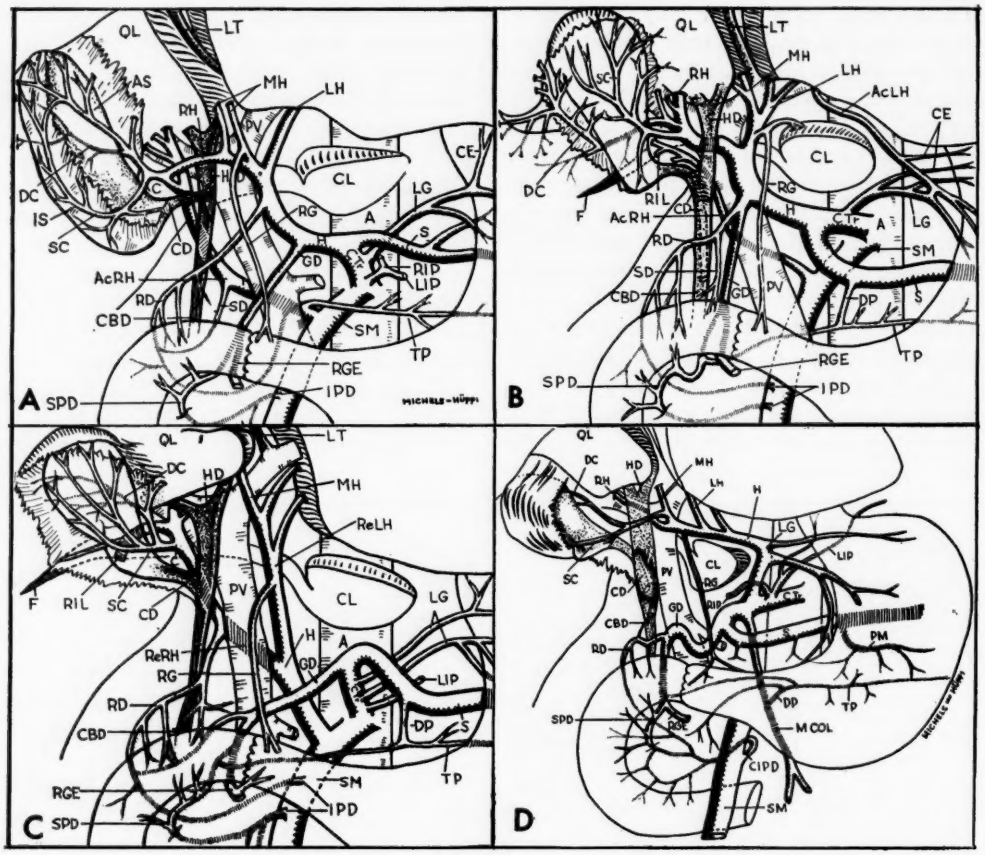

Fig. 3.

duct, or from some other source, as the middle hepatic, left hepatic, gastroduodenal and retroduodenal. *Dual cystic arteries, accordingly, are not fortuitous anomalies but constitute a prevalent mode of blood supply to the gallbladder, they having been observed in 50 (25 per cent) of the 200 specimens investigated.*

This percentage of dual cystics is considerably higher than that reported by Lipshutz (10 per cent), Daseler and his collaborators (14 per cent), Flint (15 per cent), Belou (19 per cent), Brown (21 per cent) and many others. The high incidence (25 per cent) is due to the fact that I dissected the hepatic branches up to their very entry into the liver, thereby on many occasions finding a high, hidden cystic, which usually turned out to be the deep branch. Furthermore, in many cases the points of origin of the two cystic arteries from the right hepatic were so close as to simulate one cystic, when actually two were present. Only 1 triple cystic was observed in 200 bodies.

The statistics with regard to the various modes of origin of the single and double cystic arteries and the normal and aberrant arteries from which they spring are too long and too varied to be recorded

Fig. 3.—*A*, type with an accessory right hepatic (*AcRH*) as the hepatic divides into left, middle, and right branches. Since the celiacal right hepatic gives off only the cystic (*C*) and a very small liver branch, an accessory right hepatic (*AcRH*) from the superior mesenteric supplies the right lobe; before doing so, it anastomoses with the right hepatic. The *retroduodenal* (*RD*) is a branch of the hepatic and not of the gastroduodenal, *thereby justifying its own terminology*. It descends anterior to the common bile (*CBD*), forms an extensive arcade on the posterior surface of the duodenum and head of the pancreas, then unites with the accessory right hepatic via its own inferior pancreaticoduodenal (*IPD*). The cystic duct (*CD*) joins the common hepatic duct anteriorly and to the left; it is dangerously close to the accessory right hepatic (*AcRH*). The latter gives off the supraduodenal (*SD*), which anastomoses with the retroduodenal. Single cystic artery with typical distribution of its superficial and deep branch. *B*, type in which the liver has five major arteries, three from the celiacal hepatic and two accessory hepatic arteries (accessory right hepatic (*AcRH*) from the superior mesenteric (*SM*), the accessory left hepatic (*AcLH*) from the left gastric (*LG*). The deep cystic (*DC*), after giving off a liver branch and supplying the attached surface of the gallbladder, ramifies in areas beyond it as a relatively large liver artery. The cystic duct (*CD*) is long (6 cm.) and serves posterior to the hepatic duct with which it is intimately united with connective tissue for 7.5 cm. before opening into the common bile duct (*CBD*). Note how the accessory right hepatic (*AcRH*), most likely the posterior segmental branch of the right lobe, enters the fissured area under the gallbladder and how readily it may be mistaken for the cystic. *C*, type without a celiacal hepatic. The entire blood supply of the liver comes from the superior mesenteric (*SM*) via a replaced common hepatic, the right branch of which courses upward dorsal to the portal vein (*PV*). Note close relation of the cystic artery (*C*) to the large liver artery (most probably the posterior segmental branch of the right hepatic [*RIL*]), as latter enters the fissured area under the gallbladder. Such a common hepatic may pass through the head of the pancreas, where it inadvertently may be severed. The retroduodenal arcade here is double; the upper unites with the gastroduodenal, the lower with the superior mesenteric via its own inferior pancreaticoduodenal (*IPD*). *D*, hepatic trunk from left gastric; surgically considered, very dangerous in partial or total gastrectomy. Here the entire blood supply of the liver and gallbladder comes from the left side, i.e., from the left gastric via a replaced hepatic trunk which ran at the periphery of the lesser omentum and on opening the abdomen was largely hidden from view. The cystic arises from the middle hepatic (*MH*) and after crossing the hepatic duct divides into its superficial (*SC*) and deep branch (*DC*). Surgically considered, it is important to know that the middle colic (*M. Col.*) may arise from the celiac, and give origin to the dorsal pancreatic, as here. Branches of the left inferior phrenic artery supply the esophagus.

here, except in summary. Of great import in the search for the cystic artery is the fact that in nearly 20 per cent of the 200 cases no cystic artery had its origin in Calot's triangle, while in 80 per cent there was always the origin of a cystic in the triangle, either the single cystic, the superficial branch, the deep branch or both branches. Cystic arteries arising from a typical celiac right hepatic in the triangle comprised: single cystic, 43 per cent; double cystic, 11.5 per cent, and either the superficial or the deep branch, 8 per cent —a total of 63 per cent. Aberrant right hepatics gave rise to the cystic in the triangle in 18 per cent. The single cystic, its superficial or its deep branch arose from the right hepatic to the left of the hepatic duct in 19.5 per cent; from the left hepatic, middle hepatic or common hepatic in 6.5 per cent and *from the gastroduodenal or its retroduodenal branch in 4 per cent*. An origin of the cystic artery, especially the deep cystic, from an aberrant replaced right hepatic artery from the superior mesenteric occurred more frequently (11 per cent) than from a hepatic artery of similar origin which was accessory (3 cases). Of the 50 cases in which dual cystic arteries were observed, only 2 did not reveal the origin of a cystic artery from the right hepatic in Calot's triangle.

The Biliary Ducts. — Variations in the bile ducts are of such frequency and of such pronounced character as to be of vital concern to every surgeon. A disregard of the anomalies, especially of accessory hepatic ducts, courts injury to them, with resultant disconcerting postoperative leakage of bile. That the majority of benign strictures of the common duct are due to surgical injury during cholecystectomy is well known and has recently again been emphasized by Lahey, Wilson and Gillespie, Ravdin, Cole, Walters and Philipps, and many others. Lahey stressed the fact

that injuries are more apt to occur to the hepatic duct than to the common bile duct.

What seemingly is the common bile duct is often not the common duct but the hepatic duct firmly united by dense connective tissue with the cystic duct, constituting the well-known, short (1 to 3 cm.) and long parallel cystic ducts (6 cm.). The length of the hepatic duct depends on the site of opening of the cystic duct, which may occur anywhere along the duct, even on its anterior aspect and, after a half circle spiral, on its left side. In cases in which the union of the two ducts has been prolonged to the level of the duodenum (6 cm.) or to a point just above or below it, there is usually no supraduodenal portion of the common bile duct, or very little. Such long-veiled and hidden cystic ducts may not only harbor residual gallstones but, because of their abutments to the hepatic duct, may lead to injury of the latter during cholecystectomy.

Accessory hepatic ducts are but aberrantly placed low (extrahepatic) tributaries to the hepatic duct, to its right or left branch, to the common duct or to the cystic duct itself. In this sense the term "aberrant hepatic duct" is much more appropriate than the term "accessory." This was shown by Healey and Schroy, who in 1953 made the *first statistical analysis of the bilobar segmental arrangement of the biliary tree* as observed in 100 liver corrosion casts made with vinyl acetate injections at the Daniel Baugh Insti-

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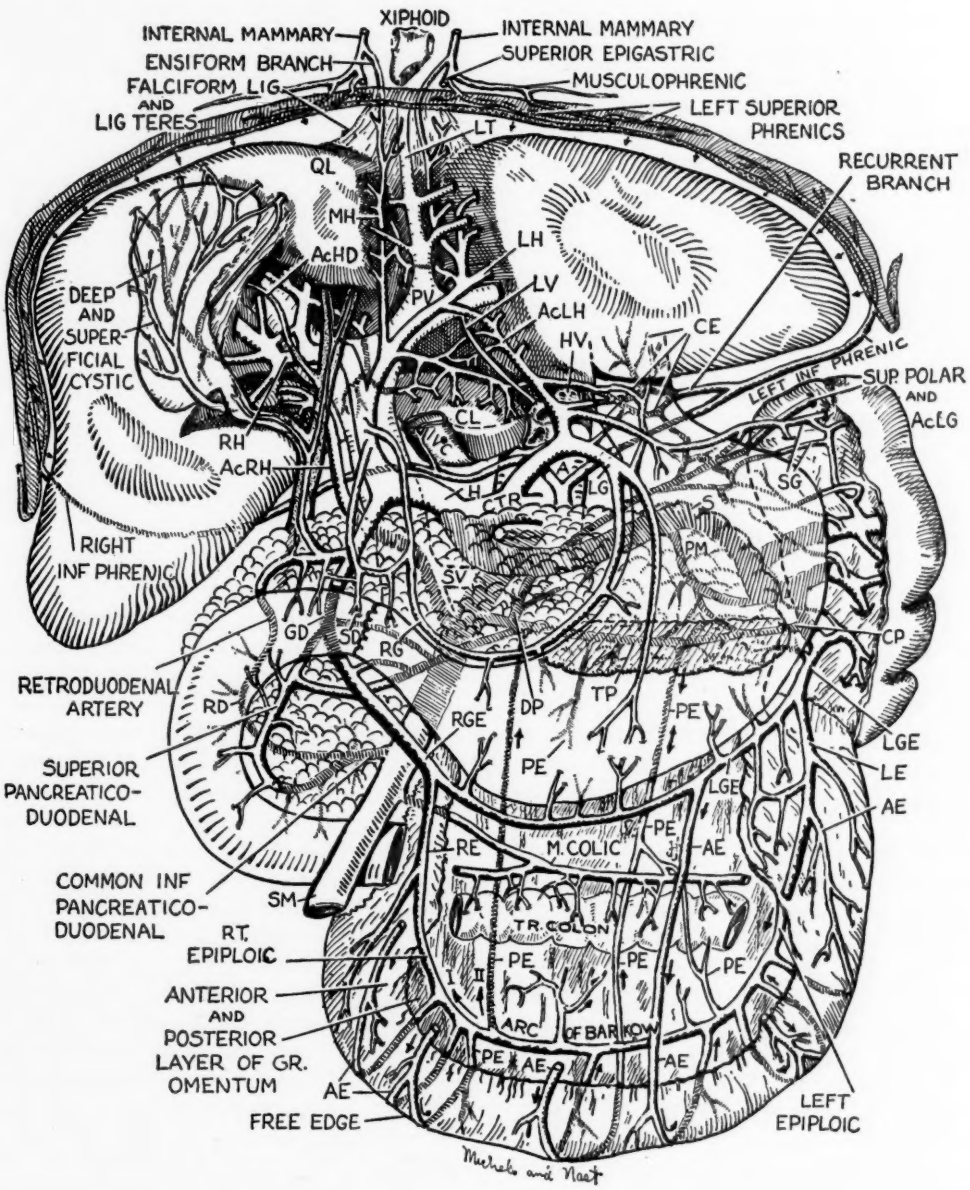
Fig. 4.—Some of the 26 collateral arterial pathways to the liver, as ascertained in 200 dissections: 1. Routes through hepatic arteries arising from sources other than the common celiac hepatic trunk. 1. Accessory left hepatic (*AcLH*) from the left gastric (*LG*). 2. Accessory right hepatic (*AcRH*) from superior mesenteric (*SM*). 2. Nonhepatic routes capable of connecting with branches of severed hepatic arteries: 1. Infragastric via right and left gastroepiploics (*RGE*>*<LGE*) and gastroduodenal (*GD*) to the right, and short gastrics (*SG*) to the left. 2. Supragastric, via right and left gastrics (*RG*>*<LG*). 3. Infracolic, via the arc of Barkow in posterior layer of the great omentum, blood may be routed directly into the gastroduodenal (*GD*) through right gastroepiploic (*RGE*) and right epiploic (*RE*) in Type 1; indirectly into it via posterior epiploic (*PE*), transverse pancreatic (*TP*) and its connections in Type 2. Left limb of arc is always made by the left epiploic (*LE*). 4. Paraesophageal—or hepatogastric. Cardioesophageal (*CE*) branches from the left gastric (*LG*) and splenic (*S*) via its short gastrics (*SG*) unite with similar branches from accessory left hepatic (*AcLH*). 5. Retroesophageal. Recurrent branch of left inferior phrenic gives off cardioesophageal (*CE*) branches that unite with those derived from accessory left hepatic (*AcLH*), short gastrics (*SG*), and accessory left gastric (*AcLG*). 6. Transpancreatic. Blood leaving the splenic (*S*) through the dorsal pancreatic (*DP*) or a. pancreatica magna (*PM*) and caudal pancreatic (*CP*), or coming from the arc of Barkow through a posterior epiploic (*PE*) enters the transverse pancreatic (*TP*) via which it may course into the superior pancreaticoduodenal (*SPD*), right gastroepiploic (*RGE*) or gastroduodenal (*GD*) to reach the hepatic trunk (*H*). 3. Routes over arteries outside of the celiac blood supply. 1. Superior mesenteric (*SM*) via the inferior pancreaticoduodenal and the anterior and posterior pancreaticoduodenal arcades respectively made by the retroduodenal (*RD*) and superior pancreatocoduodenal (*SPD*), branches of the gastroduodenal (*GD*). 2. Superior mesenteric via its transverse pancreatic (*TP*) branch, which may connect with the *SPD*, *RGE* or *GD*. 3. Inferior phrenics coursing in the diaphragm unite with branches of the hepatic at attached areas of liver. Cardioesophageal (*CE*) branches of the recurrent branch of the left inferior phrenic anastomose with subcapsular branches of the hepatic in fossa for ligamentum venosum. 4. Superior phrenic from the terminal branches of the internal mammary, i.e., superior epigastric and musculophrenic communicate with branches of hepatic in diaphragm. 5. Ensiform branch of the internal mammary (Haller, 1756) coursing in the falciform ligament and ligamentum teres unite with terminal falciform branches given off by the left (*LH*) and middle hepatic (*MH*). 6. Vasa vasorum. An arteriole derived from the right inferior phrenic courses upward to liver along inferior vena cava (*IVC*). 7. Supply along the biliary ducts by arteriole *derived from the retroduodenal* (*RD*).

The collateral pathways outlined here on an anatomic basis, many of them small and insignificant, should *by no sort of deductive reasoning give rise to the impression that ligation of a major hepatic artery can be performed with impunity.* Behrend, Gordon-Taylor, Vaughn, Gray and Ramström have definitely committed themselves to the opinion that some of the so-called "liver deaths" following cholecystectomy are attributable to severance, ligation or clamping of the right hepatic artery. The actual efficiency of the outlined twenty-six collateral pathways to the liver can be determined only in further studies, including animal experimentation, arteriograms and postmortem investigations.


XIPHOID
INTERNAL MAMMARY
INTERNAL MAMMARY
ENSIFORM BRANCH
SUPERIOR EPIGASTRIC
FALCIFORM LIG.
AND
LIG TERES
MUSCULOPHRENIC
LEFT SUPERIOR
PHRENICS
RECURRENT
BRANCH
LT
QL
MH
AcHD
LH
LV
AcLH
PV
CE
HV
DEEP
AND
SUPER-
FICIAL
CYSTIC
LEFT INF PHRENIC
SUP. POLAR
AND
AcLG
CL
RH
AcRH
IVC
CTR
LG
SG
RIGHT
INF PHRENIC
PM
SV
GD
SD
RG
CP
RETRODUODENAL
ARTERY
RD
RGE
DP
TP
PE
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LE
AE
SUPERIOR
PANCREATICO-
DUODENAL
M. COLIC
RE
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COMMON INF
PANCREATICO-
DUODENAL
TR. COLON
RT.
EPIPLOIC
I
II
ANTERIOR
AND
POSTERIOR
LAYER OF GR.
OMENTUM
ARC OF BARKOW
AE
FREE EDGE
LEFT
EPIPLOIC
Michels and Naef

Fig. 4.

tute of Anatomy of the Jefferson Medical College.

Following the usual mode of designating an accessory hepatic duct as one that is prone to be injured in biliary operations, i.e., one coursing in the cystic triangle, I observed, in this series of 200 bodies, 36 cases (18 per cent) of accessory hepatic ducts. In 10 per cent they joined the hepatic duct, in 3.5 per cent the right branch of the hepatic duct and in 1 per cent the common bile duct. In 2 per cent the cystic duct drained into an accessory hepatic duct which joined the normal hepatic duct. In 1 case two accessory hepatic ducts joined the hepatic duct. In another case one accessory duct joined the right branch of the hepatic duct and the other the hepatic duct. Contrary to general opinion, an accessory duct may arise from the *left side*. In 1 case such a duct came from the caudate lobe and joined the hepatic duct; in another, it joined the common bile duct, the cystic artery passing between it and the hepatic duct. Of surgical importance is the fact that, in many instances, an accessory hepatic duct arises or courses under the gallbladder. Being filamentous, such a *subvesicular duct* may be mistaken for strands of fibrous tissue or a nerve and can readily be torn or severed during cholecystectomy, causing disconcerting postoperative jaundice. In their corrosion casts Healey and Schroy observed the incidence of subvesicular ducts to be 35 per cent.

The Retroduodenal Artery. — It is in virtue of this artery that the duodenum is the only section of the intestine that has an anterior and posterior blood supply, the retroduodenal supplying the back of the duodenum. In a few recent texts (Grant, Anson, Philip Thorek, Hollinshead, Morris), the artery is named the posterior superior pancreaticoduodenal to distinguish it from the anterior superior pancreaticoduodenal.

Double pancreaticoduodenal arcades, one anterior and the other posterior to the head of the pancreas and back of the duodenum and made by different arteries, were first described by Haller in his Latin text in 1752. Forgotten because of an indefinite terminology for nearly two centuries, the artery on the back of the duodenum was unsuccessfully resuscitated by Belou of Buenos Aires in 1915 and by Petrén of Sweden in 1929 with the long descriptive term—posterior superior pancreaticoduodenal artery. Since the term proved too cumbersome to be remembered and since in 10 per cent of the present cases the artery forming the posterior duodenal arcade arose from an artery other than the gastroduodenal (which the superior pancreaticoduodenal rarely does), the term "retroduodenal" is used. *The term is shorter and can readily be remembered by every surgeon.*

Typically, the retroduodenal artery arises as the first *collateral* branch of the gastroduodenal. Its site of origin from the latter lies above, occasionally behind the duodenum and head of the pancreas and is often cryptic, being hidden by dense fibrous tissue. In its downward course it descends for several centimeters along the left side of the common bile duct, crosses its supraduodenal portion anteriorly and again descends for a centimeter or more along the right side of the common duct. At about the middle of the posterior surface of the head of the pancreas behind the intrapancreatic part of the common bile duct it forms a U-shaped, scalloped posterior pancreaticoduodenal arcade, branches (seven to ten) of which supply all three parts of the duodenum and, to a lesser extent, the head of the pancreas in the back. In its secondary and tertiary arcades, the posterior pancreaticoduodenal arcade is comparable to the anterior arcade made by the superior pancreaticoduodenal. Both arcades unite with the

superior mesenteric artery or its first jejunal branch via a common inferior pancreaticoduodenal artery (60 per cent) or each arcade has its own inferior pancreaticoduodenal, that of the posterior arcade arising at a higher level in back of the pancreas.

Ramifications of the retroduodenal about the supraduodenal, retroduodenal, and intrapancreatic portion of the common bile duct accounts, in a large measure, for the rich vascularization of the common duct, the latter again being crossed near its distal end by several branches from the retroduodenal arcade. The posterior arcade comes to perfect display with mobilization of the duodenum and removal of a thin film of connective tissue (Toldt's fascia, remnant of the primitive mesoduodenum) that overlies it and the retroduodenal venous arcade. The latter is superficial to the arterial arcade and drains into the portal vein.

The retroduodenal artery is of decided surgical importance, for the following reasons:

1. The entire cystic artery (2 cases) or its superficial branch (6 cases) may arise from it. 2. In incisions of the common duct for removal of gallstones it may readily be injured, for it crosses its supraduodenal portion anteriorly. 3. One or two end branches of its arcade often cross under the superior mesenteric artery to supply the first part of the jejunum, a point to be remembered in gastrojejunostomies, *lest the first part of the small bowel be deprived of its blood supply.* 4. In ligations, explorations and transplantations of the common bile duct, especially of its intrapancreatic portion, the retroduodenal artery should be taken note of in order to avoid annoying hemorrhages. 5. In hidden bleeding that follows spontaneous rupture of the posterior duodenal wall by ulceration, the retroduodenal artery may be involved, more so than the supraduodenal or the gastroduodenal. 6. In many instances it forms a suprapancreatic arcade with the supraduodenal artery of Wilkie or with the right gastric artery, the arcade supplying the critical arterial transition zone between the pylorus and the first part of the duodenum with a fountain-like spray of twigs. 7. It may be anastomosed with the splenic or the celiac artery via a branch of the dorsal pancreatic artery which passes behind the common bile duct.

Relations of Arteries to the Biliary Ducts.—Relations of the biliary ducts to the right hepatic artery and its branches, especially the cystic, depend on the varied origin and mode of branching (early or late) and the course taken by the right hepatic. The following anatomic facts merit repeated recollection and didactic emphasis. In nearly 20 per cent of the cases the site of origin of the cystic artery is located outside the cystic triangle, i.e., the artery arises to the left of the hepatic or gastroduodenal artery and must, accordingly, cross the bile duct system (usually the hepatic duct) to reach the triangle.

In the majority of cases the celiac right hepatic artery crosses the hepatic duct posteriorly, purely ventral crossings having been observed in only 12 per cent. In many instances the right hepatic is represented by two branches, one crossing the hepatic duct anteriorly, the other posteriorly. In cases of dual cystics, when the superficial cystic arises from an artery to the left of the hepatic duct (right, middle or left hepatic), it usually crosses the hepatic duct anteriorly. In such cases the deep cystic artery may arise in the triangle from an aberrant right hepatic derived from the superior mesenteric which, in its ascent to the triangle, crossed the common bile duct, often at the point of juncture of the cystic duct where it may be injured or severed. In 7 per cent of the cases the superficial cystic swung cau-

dally around the proximal end of the cystic duct, i.e., left Calot's triangle to reach the peritoneal surface of the gallbladder, an item to be remembered in locating the superficial cystic. When the entire cystic artery or its superficial branch arises from the gastroduodenal or its retroduodenal branch, it must cross the common bile duct and often the cystic duct to reach the gallbladder. This common pattern should be borne in mind, since ordinarily the surgeon does not look for a cystic artery caudal to the cystic duct.

An artery that looks like a cystic and courses near and parallel with the cystic duct is not necessarily the cystic artery. It may be (1) an early liver branch of the right hepatic; (2) the lower branch of a right hepatic that bifurcated either in the triangle or before it crossed the hepatic duct, or (3) an aberrant right hepatic from the superior mesenteric or a branch of it being distributed to the fissured area, often found under the gallbladder. The detected cystic may be only one of the cystics, because frequently the right hepatic divides in the triangle into two major branches, one giving off the superficial and the other the deep cystic. Often the level of origin of the two cystics is far apart, placing the deep cystic high in the triangle, where it may be overlooked in a cholecystectomy. When torn, such a deep cystic may retract into the liver substance, effecting nevertheless very annoying hemorrhage.

The triangle may contain two right hepatic arteries of different origin, one arising from the celiacal right hepatic and the other from the superior mesenteric, the latter and not the former giving off the cystic. Approaching the cystic duct, such an aberrant right hepatic may erroneously be ligated instead of the cystic, causing severe necrosis of the liver with a fatal result.

In Calot's triangle a right hepatic of celiac origin may be high, low, or intermediate in position, depending on where it crossed the hepatic duct and, having crossed it, how and where it courses in the triangle. If it emits the cystic in the triangle, that artery will have a similar orientation, high, low or intermediate in position.

Union of the right and left branches of the hepatic duct usually occurs high in the portal fissure but may be retarded, giving rise to a short, low-forked hepatic duct. Through this fork, under or over it, the right hepatic or the cystic artery may pass. The situation may be the reverse of this (high-forked hepatic duct) with similar orientation of the two vessels.

Even after crossing the hepatic duct or the latter's right and left branch at a high level (high-forked hepatic duct), the right hepatic often descends in the cystic triangle to a region dangerously close to the cystic duct. The main reason for this is the fact that, both inside and outside the triangle, *the right hepatic often makes a characteristic caterpillar-like loop with a convexity that points downward, upward, to the right or to the left. In cholecystectomies such sinuosities of the right hepatic are extremely vulnerable, for the cystic may arise from the distal or proximal end of the loop, in the latter instance crossing it, usually anteriorly.*

Arterial relations to accessory hepatic ducts are often surgically dangerous and difficult to analyze. Since an accessory hepatic duct can traverse any part of the cystic triangle, the course of the right hepatic and the site of origin of the cystic may be above or below it. A high cystic artery may cross a low accessory hepatic duct, and vice versa. Fortunately, most of the accessory hepatic ducts joining the right branch of the hepatic duct are sufficiently high to be removed from surgical harm, but those joining the cystic duct or running parallel to it decidedly are not.

Extremely vulnerable is an accessory hepatic duct that joins the common bile duct below the cystic duct and the filamentous type observed in the gallbladder bed (subvesicular duct).

In conclusion, it may be stated that the relations of the right hepatic and those of the cystic artery to the biliary ducts are far too varied and complicated to be remembered individually by the surgeon. Since each case is different, each case merits careful and purposeful inspection. From this study of anatomic relations as revealed in 200 painstaking dissections over a period of six years, and from the successful procedure of experienced surgeons, there ensues but one logical conclusion, viz., that the cystic artery should be looked for on the gallbladder itself. Since the superficial cystic ramifies on the free peritoneal surface of the gallbladder, where it can readily be seen by following it medially and caudally, the deep cystic, in the majority of cases, comes to view. If not, then most likely two cystics are present; i.e., the superficial and deep branch have different sites of origin, the deep cystic often being high and hidden in the upper part of Calot's triangle and the superficial cystic coming from a source other than the celiac right hepatic, e.g., from the middle hepatic, left hepatic or gastroduodenal.

Collateral Circulation to the Liver.—In textbooks of anatomy and surgery, either domestic or foreign, no mention is made of collateral arterial pathways to the liver. From the data obtained in this study it may be concluded that there are at least twenty-six possible collateral pathways whereby arterial blood may reach the liver. Succinctly summarized, these comprise:

1. Ten basic routes via aberrant hepatic arteries (replaced or accessory) arising from the superior mesenteric artery, the left gastric artery or other sources.

2. Six nonhepatic routes capable of connecting with severed hepatics: (1) infragastric (right and left gastroepiploic); (2) supragastric (right and left gastric); (3) infracolic (arcade of Barkow in the posterior layer of the great omentum below the transverse colon); (4) paraesophageal or hepatogastric (cardioesophageal branches from the left gastric and splenic uniting with similar branches of the severed left hepatic); (5) retroesophageal (recurrent branch of the left inferior phrenic via union of its cardioesophageal branches with the severed left hepatic), and (6) transpancreatic (pancreatic arteries uniting with the gastroduodenal).

3. Ten routes over arteries outside the celiac blood supply: (1) superior mesenteric via the inferior pancreaticoduodenal; (2) superior mesenteric via the transverse pancreatic; (3) inferior phrenic communicating with branches of the hepatic in the diaphragm; (4) superior phrenic from the internal mammary to the hepatic branches in the diaphragm; (5) falciform ligament and ligamentum teres via the *ramulus ad appendicem ensiformen* of the internal mammary (Haller) uniting with branches of the middle or left hepatic; (6) arteries coursing in the coronary, right and left triangular ligaments; (7) intercostals; (8) arteries of the posterior abdominal wall; (9) fine arterioles (vasa vasorum) in the hepatic veins, portal vein and inferior vena cava, and (10) filamentous arterioles coursing along the biliary ducts.

It should be emphasized, however, that the blood supply of the liver *is always unpredictable* and that, because of the anatomic variations that exist, relatively few of the listed collateral pathways can definitely be relied upon to establish an adequate compensatory circulation in the liver when the main common hepatic trunk or the celiac has been ligated. The fact that some patients have survived therapeutic ligation of the common hepatic is counter-

balanced by cases in which the result was fatal.

The collateral pathways outlined here on an anatomic basis, many of them small and insignificant, *should by no sort of deductive reasoning give rise to the impression that ligation of a major hepatic artery can be performed with impunity.* Behrend, Gordon-Taylor, Vaughn, Gray, and Ramström have definitely committed themselves to the opinion that some of the so-called "liver deaths" following cholecystectomy are attributable to severance, ligation or clamping of the right hepatic artery. The actual efficiency of the outlined twenty-six collateral pathways to the liver can be determined only in further studies, including animal experimentation, arteriograms and postmortem investigations.*

ZUSAMMENFASSUNG

Der Verfasser gibt eine ausführliche Beschreibung der komplizierten und ständig wechselnden Blutversorgung der Leber einschliesslich des Kollateralkreislaufs. Besonders hervorgehoben wird die Notwendigkeit, sich den ununterbrochenen Wechsel des Bildes vor Augen zu halten und ihn sorgfältig in Erwägung zu ziehen, wenn ein erheblicher chirurgischer Eingriff geplant wird. Da die Blutversorgung der Leber stets unberechenbar ist und wegen der vorkommenden anatomischen Varianten, kann man sich nach Abbindung des zur Leber führenden Hautstammes der A. coeliaca nur auf wenige kollaterale Gefässe zur Herstellung einer ausreichenden kompensatorischen Blutzufuhr verlassen. Unter keinen Umständen darf man daher annehmen, dass die Unterbindung der grossen Leberarterie ungestraft vollzogen werden kann. Die Arbeiten von Behrend, Gordon-Tayler, Vaughn, Grey, und Ramstrom weisen darauf hin, dass manche sogenannte Fälle von Lebertod nach Gallenblasenresektion auf Durchschneidung, Unterbindung oder Abklemmung der rechten Leberarterie zurückzuführen sind. Die wirkliche Leistungsfähigkeit der 26 kollateralen Gefässe der Leber kann nur durch weitere Untersuchungen, zu denen Tierexperimente, arteriographische Studien und Obduktionsbefunde gehören, bestimmt werden.

RÉSUMÉ

L'auteur décrit en détail le mécanisme de l'apport sanguin hépatique, compliqué et très variable, ainsi que de la circulation collatérale. Il insiste sur la modification constante du tableau, qui prend une importance particulière en cas d'opération. Il résulte d'un apport sanguin hépatique toujours imprévisible, et de certaines variations anatomiques éventuelles, que l'on ne peut compter que sur un petit nombre de canaux collatéraux pour établir une circulation compensatrice suffisante dans le foie en cas de ligature du tronc hépatique principal de l'artère coeliaque. C'est pourquoi l'on ne peut jamais assumer que la ligature de l'artère hépatique majeure peut être pratiquée impunément. D'après les études de Behrend, Gordon-Taylor, Vaughn, Gray, et Ramstrom, certains décès soitdisant hépatiques après cholécystectomie sont attribuables à la section, à la ligature ou au clampage de l'artère hépatique droite. Le plein fonctionnement des 26 canaux collatéraux du foie ne peut être déterminé que par des études supplémentaires, incluant l'expérience sur l'animal, les examens artériographiques et l'autopsie.

SUMARIO

O A. descreve minuciosamente a circulação hepática que é tão variável e com-

*For references cited in this paper and for more detailed information on the topics discussed, the reader is referred to the author's recently published *Atlas*, wherein are illustrated in color the most common variants in the blood supply and in the biliary drainage of the liver.

plicada. Acentua que os aspectos são perpetuamente diversos, fato que deve ser levado emc consideração quando se planeja realizar operações importantes nesse orgão. Atendendo a que o afluxo arterial é tão imprevisivel e porque existem tantas variações, poucos vasos colaterais devem ser atingidos nos casos em que é necessário contar com uma circulação colateral depois da ligadura da arteria principal. De forma alguma pode-se admitir que a ligadura da grande arteria hepática seja realizada inpunemente. De acordo com os estudos feitos por Behrend, Gordon-Taylor, Vaughn, Gray, e Ramstrom, algumas das chamadas mortes de causa hepática após as colecistectomias, dão atribuidas a lesão, ligadura ou pinçamento da arteria hepática direita. A eficiência atual das vinte e seis colaterais do figado so poderá ser determinada por estudos futuros, nos quais se incluem a experimentação nos animais, as pesquizas arteriográficas e a necrópsia.

RESUMEN

El autor describe en detalle la Michels complicada y constante variedad de abastecimiento sanguineo hepático, incluyendo la criculación colateral. Gran enfasis es puesto en el hecho que el cuadro es continuamente variado y que esto hecho debe ser recordado y considerado con la mayor seriedad cuando una operación mayor es llevada a cavo. Como la circulación hepática es tan poco definida y porque existen muchas variaciones anatómicas se puede confiar solo en pocas de los canales colaterales para establecer una adecuda circulación que conpense en el lŭgado cuando el tronco principal hepático común del tronco celiaco ha sido ligada. Por lo tanto en ninguna circustancia debe considerarse que la ligadura de la arteria hepática pueda efectuarse impunemente. De acuerdo con los estudios de Behrens, Gordon-Taylor, Vaughn, Gray, y Ramstrom, algunas de las llamadas muertes hepáticas, consecutivas a una colecistectomía, son atribuides a sección, ligadura o pinzamiento de la arteria hepática derecha. La verdadera eficiencia de los 26 conductos colaterales del higado solo podran determinarse en estudios posteriores, incluyendo experimentación animal investigación arteriográfical y autopsias.

BIBLIOGRAPHY

Michels, N. A.: The Blood Supply and Anatomy of the Upper Abdominal Organs with a Descriptive Atlas. Philadelphia: The J. B. Lippincott Company, 1955.

Sometimes give your services for nothing, calling to mind a previous benefaction or present satisfaction . . . For where there is love of man, there is also love of the art. For some patients, though conscious that their condition is perilous, recover their health simply through their contentment with the goodness of the physician.

—*Hippocrates*

Cardiovascular Surgery

The Postphlebitic Leg

An Evaluation of Surgical Procedures, with Special Reference to the Preoperative Use of Ascending Functional Venographic Studies

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AN essay on the treatment of the postphlebitic syndrome should properly begin with a consideration of those measures which may be used to reduce the incidence and degree of chronic venous insufficiency following deep venous thrombosis or superficial thrombophlebitis.

The late sequelae of either of these conditions may result in the "lower leg syndrome," although the typical postphlebitic leg is generally thought of as secondary to the deep venous thrombosis.

As this communication is essentially a consideration of surgical procedures, the fundamental importance of early and adequate heparinization will be merely mentioned.

Surgical management may be divided into two categories: (1) procedures concerned with chronic venous insufficiency *per se* and (2) procedures that deal directly with the sequelae of this condition.

In the first category may be included the operations used in the treatment of thromboembolism and acute superficial thrombophlebitis, namely, superficial femoral vein ligation, common femoral vein ligation, inferior vena cava ligation and excision of acutely thrombosed superficial veins.

The incidence of the "indurated leg" that results from repeated attacks of acute superficial thrombophlebitis is not inconsiderable, and the number of cases of thrombotic extension to the deep venous system via communicating veins is probably larger than is realized.

Recent clinical observation indicates that convalescence from the acute stage may be reduced to a few days, the typical postphlebitic changes entirely eliminated and extension to the deep veins prevented by prompt and complete excision of superficial thrombosed veins. It should be especially emphasized, however, that if operation is to be performed in the acute stage it should be early in the course of the disease, because of the danger of favoring the progression of thrombosis with subsequent pulmonary embolism when the communicating veins are already involved.

With deep venous thrombosis the situation is not as simple. Although anticoagulant therapy may largely obviate the early complications and late sequelae, there will nevertheless be a certain number of cases in which thrombosis is progressive and deep vein ligation will be indicated because

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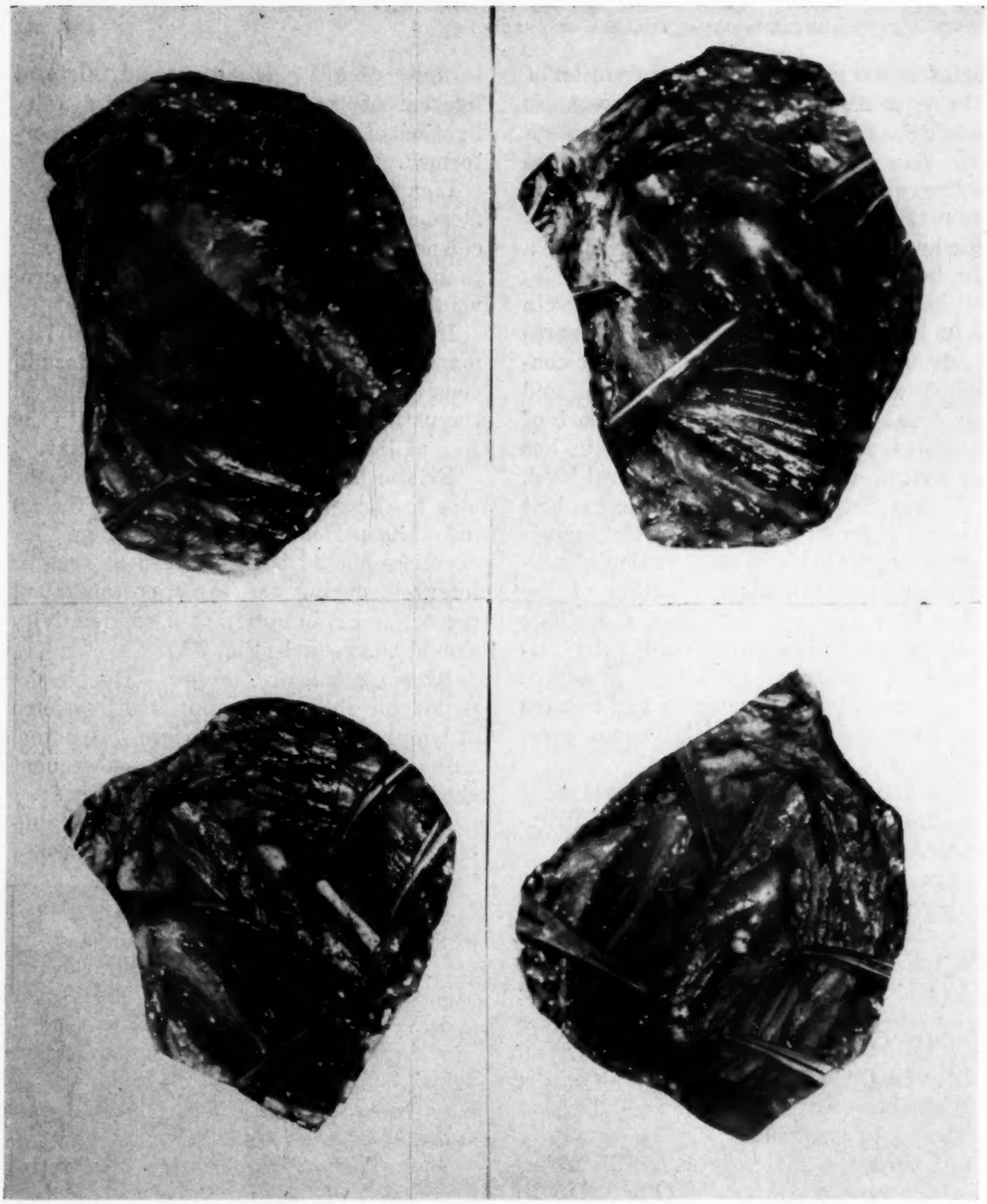

Fig. 1.—Simplified approach to origin of common femoral vein. *Upper left*, incision exposing the abductor longus muscle. *Upper right*, cleavage plane determined to lateral edge of the muscle. *Lower left*, exposure of common femoral vein origin at termination of superficial and profunda. *Lower right*, ligation of the superficial femoral vein at its termination. (*Angiology*, February 1953. Reprinted by permission.)

of the danger of pulmonary embolism.

In other cases, owing to a multiplicity of factors, physiopathologic changes may occur which eventuate in the "postphlebitic leg."

The importance of maintaining the com-

mon femoral pathway in the prevention of late sequelae of deep venous thrombosis should be recognized. The profunda femoris vein affords an abundant collateral pathway for the return of venous blood from the lower extremity when interruption by thrombus or ligature is limited to a site below the common femoral origin.

Ligation of the superficial femoral vein at its termination is a simple and comparatively innocuous procedure, does not contribute significantly to venous stasis and has considerable value in the presence of thromboembolism when the thrombus has not ascended to the common femoral level.

Unless the response to anticoagulant therapy is prompt, deep venous thrombosis should be treated by a combination of heparinization and bilateral ligation of the superficial femoral vein plus immediate ambulation. This greatly reduces the incidence of recurrent embolism, preserves the common femoral pathway and reduces the incidence of orthostatic venous overloading and stasis.

The following approach is advantageous because it is simple, direct and atraumatic.[1]

The incision, placed well medial to the neurovascular bundle, is carried down to the adductor longus muscle (Fig. 1*A*). A cleavage plane is then determined beneath the adductor longus fascia and carried over the lateral edge of the muscle to the origin of the common femoral vein (Fig. 1*B*). In this manner the femoral vein is approached directly from its medial aspect and may be isolated without the necessity of exposing the artery or surgically unimportant venous tributaries (Fig. 1*C*). Ligation is performed at the exact point of termination of the superficial femoral vein in order to prevent thrombus formation in a blind stump (Fig. 1*D*). Ligation should be bilateral.

If the source of embolization is higher than the common femoral origin, or occurs in spite of anticoagulation and bilateral ligation of the superficial femoral vein, ligation of the vena cava should be performed.

Ligation of the inferior vena cava is a more effective procedure, with a lesser incidence of incapacitating complications, than is ligation of the common femoral vein.

In order to lessen the edema and late manifestation of chronic venous insufficiency following ligation of the vena cava, the patient should be kept in bed, with the foot of the bed elevated, for two weeks.

Elastic bandages from the base of the toes to the groin should be worn for an indefinite period. Deep breathing and leg exercises should be performed at regular intervals during the early postoperative period, and resumption of normal activity should be gradual (Fig. 2*A*).

Physiopathologic Changes.—The physiopathologic changes are initiated by edema of lymphatic and venous origin. The actual bases for edema and the subsequent changes may be enumerated as follows:

1. Damage to small venules and capillaries occurring during the acute phase of the disease.
2. Permanent obstruction of thrombosed deep veins.
3. Recanalization of a thrombosed deep vein with destruction of valve function.
4. Varicosities of the secondary type.
5. Incompetence of the communicating veins.
6. Vasospasm. This is variable in degree and may be persistent.
7. Perivenous lymphangitis. Permanent perivenous fibrosis may result. Perifibrosis of the neurovascular bundle may be a major cause of continued vasospasm.
8. Poor hygiene, the moist foot incident to vasospasm, the presence of fungous infection about the toes and infected stasis ulcers afford a portal of entry for recurring attacks of lymphangitis and cellulitis,

which favor the development of subcutaneous fibrosis in an area rendered vulnerable by the presence of chronic edema.

Clinical Manifestations. — The clinical manifestatons that accompany the postphlebitic leg secondary to deep venous thrombosis will differ from the postphlebitic manifestations of primary varicose veins, both in degree and in character, because of complications in the former due to physiologic disturbances of deep venous return, the greater degree of reversed circulation in communicating veins, and vasomotor disturbances induced in perifibrosis of the neurovascular bundle, and also because of the greater amount of lymph stasis.

Typically, postphlebitic ulceration occurs adjacent to the malleoli, especially the internal, frequently on the lateral but rarely on the upper portion of the leg.

The outstanding subjective complaint is pain, which may be (1) the orthostatic pain of chronic venous insufficiency; (2) neuritis of the long saphenous nerve, or (3) causalgia accompanied by vasomotor disturbances.

The procedures used in the surgical treatment of the postphlebitic leg with reference to a direct attack on chronic venous insufficiency are:

1. Ascending functional venographic studies.
2. Surgical management of the greater and lesser saphenous systems.
3. Complete eradication of incompetent communicating veins.
4. Deep vein ligation.

Ascending Functional Venographic Studies: Ascending functional venographic studies will determine the state of: (1) the deep venous system with respect to recanalization and degree of functional integrity; (2) communicating veins with respect to location, size and degree of incompetence, and (3) superficial veins with respect to functional integrity.

The technic used is a modification of procedures previously described.[2]

The patient is placed on the roentgen table with the foot rest in position and table tilted to 75 degrees, with the feet down. A tourniquet is placed slightly above the ankles to obstruct the superficial veins.

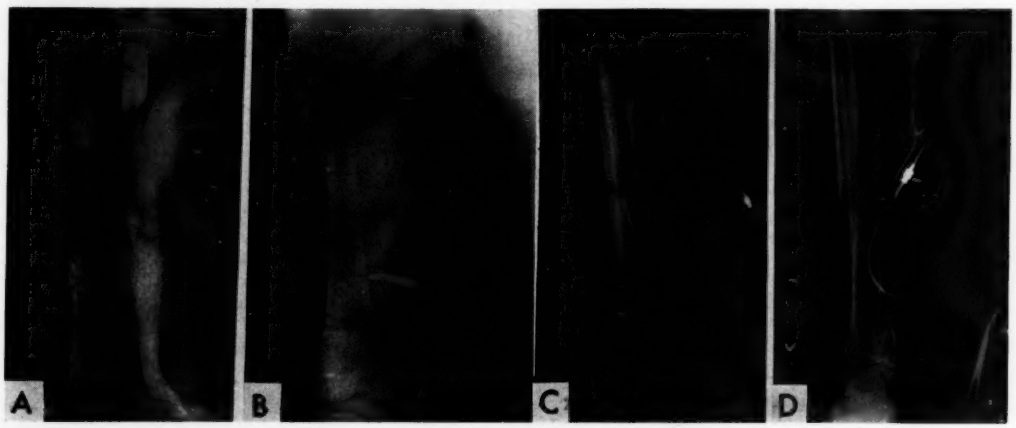

Fig. 2.—*A*, postoperative photograph of patient six months after ligations of bilateral superficial femoral vein and vena cava for recurrent pulmonary embolism following superficial thrombophlebitis with extension to the deep venous system. Note lack of edema and other evidence of chronic venous insufficiency. *B* and *C* (Case 1), failure of deep venous system to become visible. Superficial system is adequately filled; *D*, superficial veins are emptied partially after exercise.

Polyethylene tubing is inserted into the origin of the greater saphenous vein. Thirty to 40 cc. of sodium hypaque (50 per cent) is injected at a moderate rate of speed. The film is exposed as the injection is completed. This technic shunts the dye from the superficial to the deep system.

After exposure of the first film the patient is asked to exercise by raising and lowering himself on his toes. A second exposure is made approximately one minute after the first. The second film shows the result of exercise in clearing the dye and provides a comparative picture of the functional state of the deep and superficial systems.

The proximal passage of a radiopaque medium against gravity in the superficial system, combined with failure of the deep venous system to opacify, has been regarded as presumptive evidence of deep venous obstruction.[3] I concur in this opin-

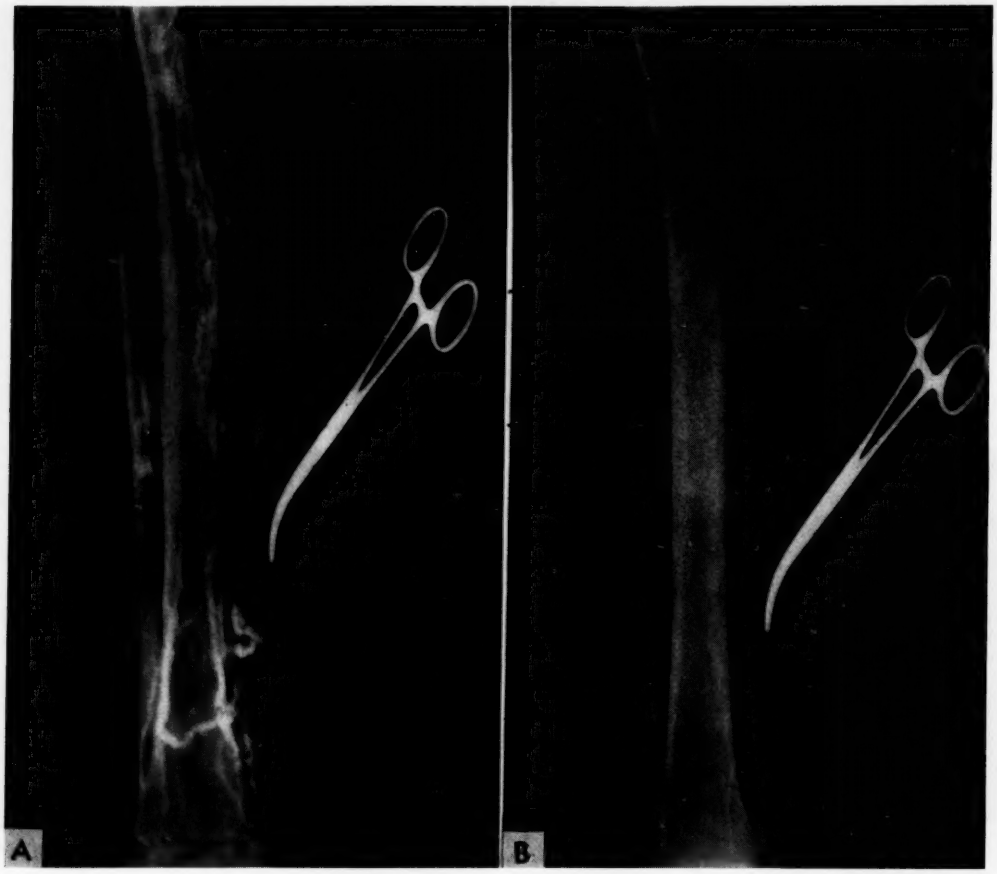

Fig. 3 (Case 2).—*A*, irregular and poorly filled deep system; greater saphenous vein fills in normal manner, and valve stations are well identified. Dilated incompetent communicating veins are well demonstrated. *B*, deep system is well cleared after exercise, while a considerable amount of dye remains in communicating and greater saphenous veins.

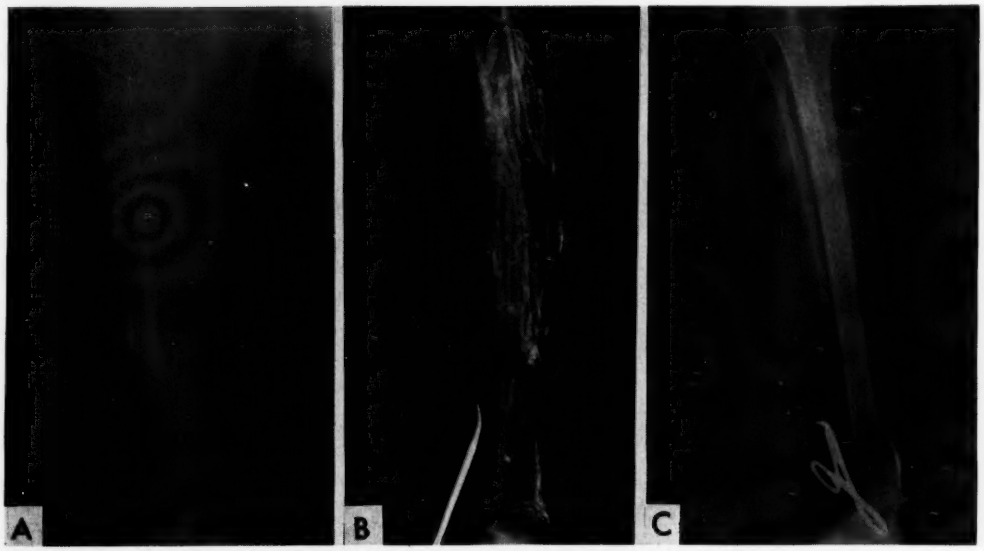

Fig. 4 (Case 3).—*A* and *B*, irregular contour and filling of deep system without visualization of valve stations. Incompetent communicating veins are identified. *C*, venogram taken after exercise shows good functional clearance of deep system, with retention of dye in superficial veins.

ion provided compression of the superficial veins with a tourniquet is effected above the level of injection.

One is impressed with the fact that these venograms frequently reveal adequate clearance of postphlebitic deep veins after exercise, in the presence of incompetent communicating veins and a poor functional response of the greater saphenous vein.

The communicating veins hold a strategic position in the syndrome under discussion. Normally they permit the flow of blood from the superficial to the deep system, owing to orientation of their valves in this direction.

It would seem that dysfunction of these veins is fundamental in the production of disabling venous stasis. Ulceration is likely to develop when the valves of these communicating veins become incompetent and the blood flow is reversed, flowing from the deep to the superficial system.

In the presence of primary varices with intact communicating veins, the compartmentalization of the superficial and deep systems will be maintained, the effects of chronic venous insufficiency will be minimized and stasis ulcer is not likely to develop. In certain circumstances, however, compartmentalization of the venous systems disappears.

When the valves of these communicating veins are rendered incompetent by distortion, as occurs in some cases of primary varicosities, or by thrombosis and recanalization, which may be associated with either superficial thrombophlebitis or deep venous thrombosis, there is a reversal of blood flow and a pronounced rise in pressure with each contraction of the calf muscles which is transmitted out to the network of subcutaneous veins, with eventual ulceration.[4]

It would seem apparent that chronic venous insufficiency following recanalization of a thrombosed deep venous system is the result not so much of altered physio-

logic function of the deep veins *per se* as of incompetence of communicating veins in which the blood flow is reversed to the tissues superficial to the deep fascia.

VENOGRAMS IN ILLUSTRATIVE CASES

CASE 1.—C. W. (Fig. 2, *B*, *C* and *D*) had a postphlebitic leg, with a history of deep venous thrombosis following typhoid fever in 1916.

The deep venous system could not be visualized. This was considered evidence of occlusion of the deep venous system.

The superficial veins filled well and emptied partially after exercise. Operation was not performed on this patient, as the superficial system of veins was considered necessary for venous return in the extremity.

CASE 2.—W. B. had had deep venous thrombosis following an appendectomy twelve years earlier.

Ulceration in the medial supramalleolar region had recurred at intervals since it first developed, two years after the attack of thrombophlebitis.

An ascending functional venogram revealed an irregular and poorly filled deep system (Fig. 3*A*). The caliber of the greater saphenous vein was normal and the valve stations well identified. Dilated and incompetent communicating veins were well demonstrated. A venogram taken after exercise (Fig. 3*B*) showed the deep system well cleared of dye, while a considerable amount remained in the communicating and greater saphenous vein.

Operation consisted of ligation of the greater saphenous and stripping and subfascial ligation and excision of communicating veins.

CASE 3.—E. D. (Fig. 4) had had deep venous thrombosis twenty-five years earlier, after childbirth. Seventeen years prior to this examination she had struck her ankle against a bedpost and an ulcer had developed in the lateral supramalleolar region. There has been recurring ulceration since that time.

Stasis dermatitis and pigmentation were present on the medial aspect of the leg.

An ascending functional venogram that reveals an irregular contour and filling and inability to identify valve stations indicates a postphlebitic state of the deep system with recanalization. Incompetent communicating veins are identified. The veins of the superficial systems are of narrow caliber.

A venogram taken after exercise shows good functional clearance of the deep system, with retention of dye in superficial veins.

Surgical procedure: Excision of the lesser saphenous system and subfascial ligation and excision of communicating veins to both greater and lesser saphenous systems through a posterior subfascial approach.

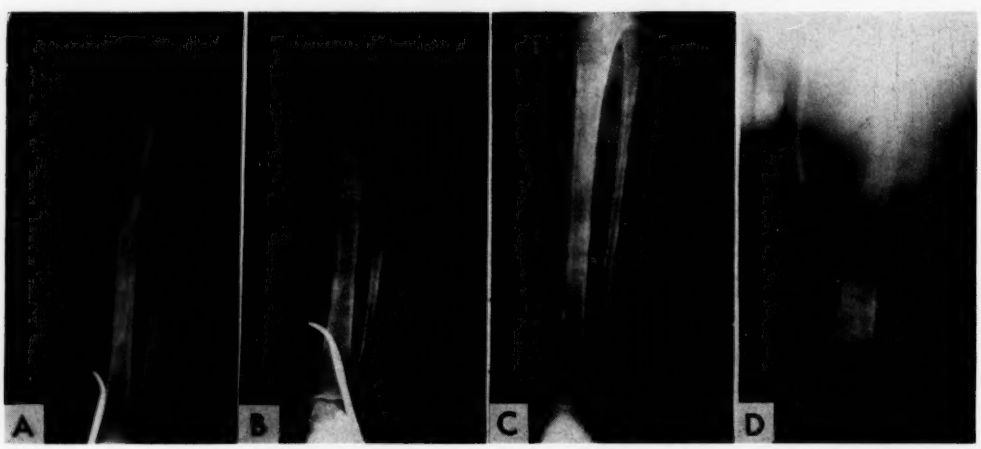

Fig. 5 (Case 4).—*A*, venogram showing incompetent communicating veins and irregular filling and narrowing of both superficial and deep systems in lower half of leg. Note well-filled and normal-appearing deep system in upper half of leg. *B*, venogram taken after exercise, demonstrating good functional response. *C* and *D*, venogram taken after injection of dye through a polyethylene catheter above the pathologic area, showing greater saphenous of good caliber with normal valve stations.

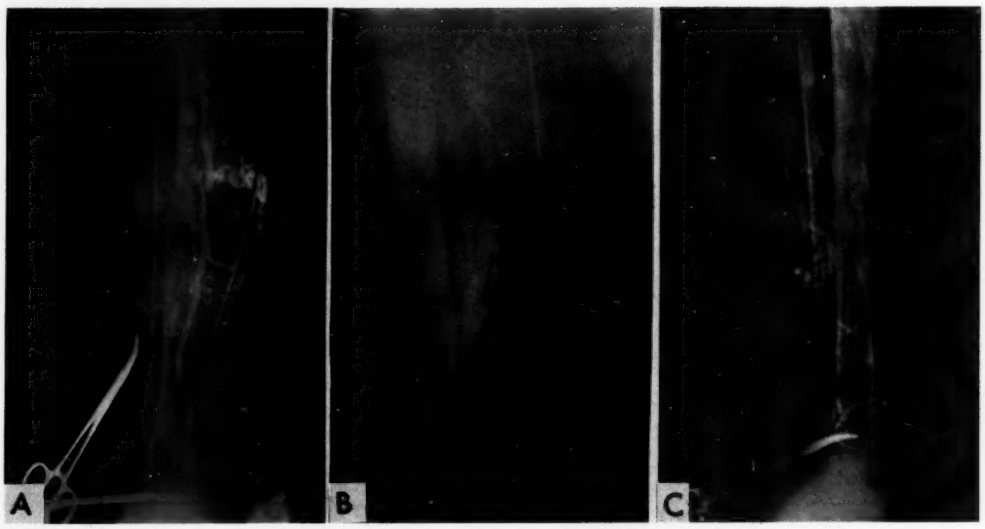

Fig. 6 (Case 5).—*A*, film demonstrating large incompetent communicating veins of both greater and lesser saphenous systems. Deep venous system in leg is incompletely and irregularly filled, but some valve stations are demonstrated. *B*, normal femoral vein is visualized above knee. *C*, venogram taken after exercise shows large communicating veins of lesser system and dye diffused into small superficial veins, with fair clearance of deep system.

CASE 4.—A. A. (Fig. 5) had a postphlebitic leg after repeated attacks of thrombophlebitis involving the lower portion of the greater saphenous system. Induration, pigmentation and dermatitis were observed on the medial aspect of the lower half of the leg. An ascending functional venogram showed incompetent communicating veins and irregular filling and narrowing of both superficial and deep systems in the lower half of the leg. The deep system in the upper half of the leg was well filled and appeared normal (Fig. 5*A*).

A venogram taken after exercise (Fig. 5*B*) demonstrated good functional response. A venogram taken after the injection of dye through a polyethylene catheter above the pathologic area (Fig. 5*C*) showed good caliber of the greater saphenous, with normal valve stations, as contrasted with the vessel in the lower part of the leg. Note that the dye passes up the greater saphenous vein without entering the deep system.

CASE 5.—E. T. (Fig. 6) had a postphlebitic leg. There had been recurrent attacks of superficial thrombophlebitis involving both the greater and the lesser saphenous system.

An ascending functional venogram showed the lumen of the greater saphenous vein decreased in caliber and irregular. Valve stations are not identified. Large incompetent communicating veins of both the greater and the lesser saphenous system are demonstrated.

The deep venous system in the leg was incompletely and irregularly filled, but some valve stations were well demonstrated (Fig. 6*B*). A normal femoral vein was visualized above the knee (Fig. 6*C*).

A venogram taken after exercise showed large communicating veins of the lesser system and dye diffused into small superficial veins with fair clearance of the deep system (Fig. 6*A*).

At operation a posterior stocking seam incision was made (Fig. 7). The greatly thickened and obliterated lesser saphenous vein was excised, and subfascial excision of communicating veins to both the greater and the lesser saphenous vein was performed as a first stage procedure.

Treatment.—Removal of the saphenous veins and their tributaries should be as nearly complete as possible when they are involved in the postphlebitic process.

The superficial veins, when contracted down and thickened in the indurated sub-

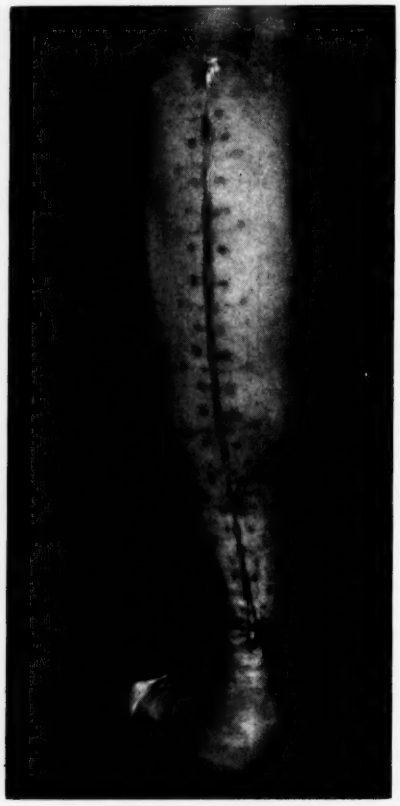

Fig. 7.—*A*, posterior (stocking seam) incision used for excision of lesser saphenous system as well as subfascial ligation and severance of communicating veins of both greater and lesser saphenous systems.

cutaneous fat, are unable to function in a normal manner, constituting as they do part and parcel of the pathologic tissue.

It has been observed that the functional integrity of the saphenous vein is compromised when communicating veins are incompetent, even though normal-appearing valve stations have been identified venographically.

Complete eradication of incompetent communicating veins, including those feeding the ulcerated area, is of the greatest importance.

Effective ligation of these communicating veins of the greater saphenous system may be performed through a longitudinal incision on the medial aspect of the leg, extending from a short distance below the knee to the medial malleolus. When the subcutaneous fascia is indurated the incision is carried beneath the deep fascia, where wide separation of muscle from deep fascia may be obtained, and in the subfascial space the vessels are double-ligated and severed. These veins may be approached satisfactorily in the plane between the subcutaneous and deep fascia when the pathologic change in the tissue is not advanced.

Elimination of incompetent communicating veins restores the compartmentalization of the leg and thus increases the functional competence of the deep venous system even after the deep venous valves have been destroyed by thrombosis and recanalization.

A posterior subfascial approach, as described by Felder and his co-workers,[5] may be used for excision of communicating veins.

A cleavage plane is determined between the deep fascia and underlying muscles to the posteromedial surface of the tibia and the posterolateral border of the fibula, giving exposure for double ligation and severance of communicating veins of both greater and lesser saphenous system (Fig. 7).

Deep Venous Ligation: The rationale of deep venous ligation is questionable in the light of functional venographic studies. It is my present opinion that ligation should not be performed when these studies demonstrate adequate clearing of the dye from the deep system.

Surgical Procedures Dealing with Sequelae of Chronic Venous Insufficiency: *Lumbar Sympathectomy.*—These procedures have a limited but definite place in the treatment of the sequelae of deep phlebitis.

1. An extremity in which vasospasm is marked, as denoted by a cool, moist and cyanotic foot, will benefit by sympathectomy, especially when it is the site of recurrent fungus infection. The foot and toes will become dry and warm, and the tendency toward recurrent lymphangitis and cellulitis will be greatly diminished.

2. The causalgic syndrome, which is an occasional complication of the postphlebitic leg, is generally completely relieved by sympathectomy.

Treatment of Stasis Ulcer.—Many ulcers can be healed by conservative methods, such as the use of contura and elastoplast bandages worn for one to two weeks without change and reapplied until healing occurs. Rest in bed, with elevation of the extremity and the application of warm saline compresses, is an effective alternate procedure. If an ulcer is clean and free of infection, there is no objection to the performance of vein surgery before healing occurs. If the stasis factor is predominant there may be considerable advantage, because rapid healing may occur after the operation (Fig. 8).

When operation is performed in the presence of ulceration, the involved area should be prepared by the use of saline compresses, and antibiotics should be employed preoperatively and postoperatively.

In cases of resistant lesions it is necessary to resort to skin grafting. In the majority of instances, excision of the ulcer base, the surrounding skin and the subcutaneous fascia, followed by the use of a split thickness skin graft, will suffice (Fig. 9). Over the malleoli, especially the medial malleolus, it may be difficult to obtain a permanent "take" with a split thickness graft. In this situation it is occasionally

Fig. 8.—*A*, large ulcer secondary to primary varicose veins. Stasis factor predominant. *B*, complete healing after adequate surgical treatment of vein, without the necessity of skin grafting. (*Angiology*, February 1953. Reprinted by permission.)

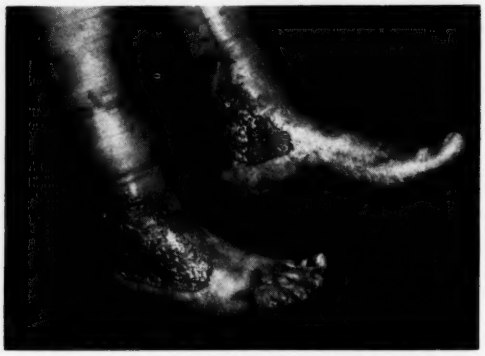

Fig. 9.—Bilateral postphlebitic ulcers secondary to deep venous thrombosis which required excision and split thickness skin grafts in addition to vascular operation plus lumbar sympathectomy.

advisable to ultilize a full thickness graft, applied preferably by the "cross leg" technic.

The Indurated Leg.—The "indurated leg" not infrequently requires block excision of pathologic tissue and application of healthy skin to the underlying muscle. In some cases the skin overlying the fibrotic and indurated subcutaneous tissue is healthy and may be utilized. In other instances the skin must be excised as well, and a split thickness graft used.

Various modifications of the Kondoleon procedure are used. A long incision is employed, and wide excision of fibrosed subcutaneous tissue is performed, with longitudinal incision or excision of deep fascia in order to allow apposition of the skin to the well-vascularized muscle. For more adequate vascularization, especially in those cases in which the skin is included in block excision and the indurated subcutaneous fascia is tightly adherent to the deep fascia, the latter is included with the excised tissue.

SUMMARY AND CONCLUSIONS

The late sequelae of deep venous thrombosis or superficial thrombophlebitis may result in the "lower leg" syndrome.

The surgical management of the postphlebitic syndrome may be divided into two categories: (a) procedures concerned with chronic venous insufficiency *per se* and (b) procedures that deal directly with the sequelae of this condition. These procedures are discussed.

Physiopathologic changes occurring in the postphlebitic leg are considered, and clinical manifestations are described.

The physiologic and anatomic factors related to the venous return of the lower extremity are discussed, with special reference to the communicating veins.

Ascending functional venographic study is considered a valuable guide to rational surgical therapy of the postphlebitic leg, as it enables one to determine the functional state of the venous systems of the lower exremity.

ZUSAMMENFASSUNG UND SCHLUSSFOLGERUNGEN

Die Spätfolgen von Thrombosen der tiefen Venen oder von oberflächlicher Thrombophlebitis können zur Entstehung des "Unterschenkelsyndroms" führen.

Die chirurgische Behandlung des postphlebitischen Syndroms lässt sich in zwei Gruppen einteilen:

a. Massnahmen, die sich mit der chronischen Insuffizienz der Venen als solcher befassen.

b. Massnahmen, die sich direkt auf die Folgezustände dieser Erkrankung erstrecken.

Diese Massnahmen werden erörtert.

Auf die physiopathologischen Veränderungen des postphlebitischen Unterschenkels wird eingegangen.

Die klinischen Erscheinungen werden beschrieben.

Die physiologischen und anatomischen Bedingungen, die auf den venösen Blutabfluss der unteren Extremität einen Einfluss haben, werden unter besonderer Her-

vorhebung der kommunizierenden Venen erörtert.

Die funktionelle aszendierende Venographie wird als ein wertvolles Hilfsmittel zur Auswahl einer rationellen chirurgischen Behandlung des postphlebitischen Unterschenkels angesehen, da dieses Verfahren die Bestimmung des funktionellen Zustandes des venösen Systems der unteren Extremitäten ermöglicht.

RÉSUMÉ ET CONCLUSIONS

Les séquelles tardives de la thrombose veineuse profonde ou de la thrombophlébite superficielle peuvent provoquer le syndrome dit du "lower leg."

Le traitement chirurgical du syndrome post-phlébitique peut être divisé en deux catégories: a) Procédés avant trait à l'insuffisance veineuse chronique per se. b) Procédés se rapportant directement aux séquelles de cet état. Ces techniques sont discutées.

L'auteur décrit les modifications physiopathologiques post-phlébitiques du membre inférieur, les manifestations cliniques de cette affection, ainsi que les facteurs physiologiques et anatomiques relatifs au retour veineux de l'extrémité inférieure, avec une mention spéciale quant aux veines communicantes.

La veinographie fonctionnelle ascendante est un guide précieux de la thérapeutique chirurgicale rationnelle, car elle permet de déterminer l'état fonctionnel du système veineux des extrémités inférieures.

SUMARIO E CONCLUSOES

As sequelas tardias da trombose venosa profunda e da tromboflebite superficial pode resultar na sindrome pós-trombotiva.

O tratamento cirúrgico das sindromes pós-flebíticas pode ser dividido em duas categorias:

(a) processos que visam a insuficiencia venosa crônica isolada;

(b) métodos que visam diretamente as sequelas.

Esses métodos são discutidos pelo A. que tambem analiza as modificações fisio-patologicas na perna pós-flebite.

Descreve as manifestações clínicas e discute os fatores fisiologicos e anatomicos que interferem no retorno venoso da extremidade com referencia especial às veias comunicante.

A venografia ascendente funcional é analizada, considerando-a o A. um subsidio valioso para a terapêutica da sindrome pós-flebitica porque auxilia a precisar o estado funcional do sistema venoso.

RESUMEN Y CONCLUSIONES

Las secuelas tardías de las trombosis venosas profundas o de las trombo flebitis superficiales pueden dar como resultados el "síndrome del miembro inferior."

El manejo quirúrgico de los sindromes postflebiticos puede diridirse en dos categorías:

a. Aquellos prodefimientos concernientes con la insuficiencia venosa crónica per se.

b. Aquellos prodecimientos que tratan directamente con las secuelas de esta condición.

Se discuten esos procedimientos.

Se consideran los cambios ocurridos en la pierna postflebítica.

Las manifestaciones clínicas se describen.

Los factores anatómicos y fisiológicos relacionados con la circulación venosa de retorno de la extremidad inferior se discuten con especial referencia a las venas comunicantes.

La venografía funcional ascendente se considera como una quia valiosa en el tra-

tamiento quirúrgica racional de la pierna postflebitica puesto que lo capacita a uno a determinar el estraco funcional del sistema venoso de las estremida des inferiores.

REFERENCES

1. Totten, H. P.: Surgical Treatment of the Post Phlebitic Leg, Angiology 4:38-55 (Feb.) 1953.

2. Scott, H. W. Jr., and Roach, J. F.: Phlebography of the Leg in the Erect Position, Ann. Surg. 134:104-109 (July) 1951. Shumacker, H. B. Jr.; Moore, T. C., and Campbell, J. A.: Functional Venography of the Lower Extremities, Surg., Gynec. & Obst. 98:257-272 (March) 1954.

3. Moore, T. C.: Functional Venography with Injection into Superficial Veins, Surg., Gynec. & Obst. 100:721-729 (June) 1955.

4. Cockett, F. B.: The Pathology and Treatment of Venous Ulcers of the Leg, Brit. J. Surg. 43:260-278 (Nov.) 1955.

5. Felder, D. A.; Murphy, T. O., and Ring, D. M.: A Posterior Subfascial Approach to the Communicating Veins of the Leg, Surg., Gynec. & Obst. 100:730-734 (June) 1955.

. . . I had seen enough to have an idea of the difficulties of an operation, but none of its pleasures: now I see a good operation with the pleasure I used to feel at the successful solution of Euclid's problems,—a pleasure greater than almost any I know. I have acquired that taste, that high relish, for these, without which no man can exert himself for the attainment of any art; and am only surprised that I was so long blind.

. . . I wish to caution you against any irritation from apparent want of confidence on the part of patients. This is one of the regular trials of a young practitioner,—one that he must expect to experience even from the lower classes, still more from the higher. Such an expression, however it may operate on the feelings, must not be allowed to influence the external appearance or conduct; for the expression of such irritation is a fair proof that the want of confidence is well founded, since it shows a want of self-command.

—*Warren*

Peace comes only from loving, from mutual self-sacrifice and self-forgetfulness. Few today have humility or wisdom enough to know the world's deep need of love. We are too much possessed by national and racial and cultural pride.

—*Donegan*

Further Experience in the Treatment of Vesical Tumors with Interstitial Radioactive Cobalt

VINCENT VERMOOTEN, M.D., F.A.C.S.

DALLAS, TEXAS

APPROXIMATELY four years ago Maxfield and I[1] began using radioactive cobalt in nylon sutures in the management of carcinoma of the bladder. Our first patient had an extensive infiltrating carcinoma involving about a third of the bladder, including the left half of the trigone. Six months after his first treatment a second implantation of radioactive cobalt in the region of the trigone and left ureteral orifice was required. The patient is still well and, as far as can be determined, free from carcinoma.

Up to the time of writing I have treated 22 patients with infiltrating carcinoma of the bladder. Five of these have died—1 from myocardial failure, 1 from pneumonia and the remaining three from metastatic carcinoma to the liver and elsewhere. One patient is still alive a year after his operation and, I am convinced, still has his carcinoma. The other 16 are well and have been free from the disease for periods varying from three months to four years.

This experience convinces me that, for for the purpose of treatment, carcinoma of the bladder should be classified into three groups. First, there are the benign papillomas — the noninvasive, single or multiple, and often recurring growths that may be considered a disease of the entire vesical mucosa. Because this disease is considered to be one of multicentric origin, or one which is readily transplanted from one area of the bladder to another, it is automatically eliminated as a tumor that should be treated with interstitial radiation unless and until some tumors of this type become actively infiltrating and invasive. At that time they change their classification into the next group.

The second group consists of the solitary, actively invasive, infiltrating carcinomas. It includes the sessile tumor, the flat-growing, infiltrating tumor and the superficially ulcerating squamous cell type of growth. Any tumor of the bladder that invades the tunica propria or muscularis is included in this group. All these are ideally treated with interstitial radioactive cobalt.

The third group is composed of tumors that have grown through the wall of the bladder and invaded the perivesical tissues. Most of the tumors of this type that I have seen are tumors that have previously been operated upon, usually by "segmental resection including a large cuff of normal adjacent bladder wall." In no case of this type have I been able adequately to control the tumor. The following three cases illustrate this fact.

C. E. M., a physician, had undergone an attempted segmental resection with transplantation of the right ureter two months before. When I saw him, there was some

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superficial ulceration in the bladder, in the region of the right ureteral orifice. There was no function of the right kidney. At operation it was observed that the carcinoma had extended outside the bladder and was infiltrating the adjacent pelvis (Fig. 1). In an attempt to help this patient, a biplanar implant of radioactive cobalt in nylon sutures was done (Fig. 2). Three months later an excretory urogram showed the right kidney to be functioning normally. Since then the patient has refused any further medical examination or treatment. He is up and about and voids once every two or three hours, but I am convinced that even though he has lived a year, he still has carcinoma.

Another patient, T.W.J., had a carcinomatous mass 5 to 6 cm. thick, occupying about half of the bladder and the true pelvis. I excavated this mass, then sewed the radioactive cobalt into what may be considered the wall of a surgically created diverticulum. Healing took place. The patient was able to void normally about once every two hours, but he died six months later from extensive metastases to the liver.

The third patient, J. S., had undergone an extensive segmental resection five months before I saw him. An exploratory procedure revealed so much infiltration of the adjacent tissue that it was technically impossible to suture radioactive cobalt in nylon sutures into the carcinoma. I compromised by plunging a number of low intensity radium needles into the growth and supplementing this procedure with telecobalt therapy.

Fig. 1.—Photograph taken at operation with bladder wide open shows only a small area of superficial ulceration inside bladder. Note extensive invasive tumor outside bladder. Carcinoma is obviously inoperable.

From these and similar experiences, I have come to realize that "recurrence following segmental resection" frequently means that the carcinoma is outside as well as inside the bladder, and that one can do little, even in the way of palliation, for such a patient. The surgeon who first treats a carcinoma of the bladder is the only one who has any chance to cure it, if it can be cured.

All of the 16 patients who were treated with radioactive cobalt and whose lesions were confined to the vesical wall now have normal bladders and void normally. If their lymph nodes are involved or distant metastases have occurred they may die from the carcinoma, but they are not and will not be "urinary cripples."

Four of the more dramatic cases seen in this series include that of the very first patient, already described, who is still well and living a normal life four years after the operation. My second patient, O.W.C., was referred to me for interstitial radioactive cobalt therapy because he had severe asthma and in his urologist's opinion could survive total cystectomy. The lesion was 6 cm. long by 3 cm. wide and infiltrated the entire thickness of the vesical wall. At the time of writing, three and a half years after treatment, his bladder is normal and has a normal capacity, and clinically he is well. Another patient, C.K.B., had a large sessile tumor overlying the left ureteral orifice (Fig. 3). After the main tumor mass had been excised, radioactive cobalt sutures were placed in the base of the tumor, the presence of the

ureteral orifice being entirely disregarded. This patient too is entirely well three and a half years after treatment. The bladder of M. L., a woman, had a capacity of less than an ounce, owing to extensive leucoplakia of the bladder which had become an epidermoid carcinoma involving about two-thirds of the organ. Now, twenty months after treatment, she still has a bladder with normal mucosa and a capacity of 2½ ounces.

In using radioactive cobalt in nylon sutures I have found that one can almost always excise enough of the intravesical portion of the growth so that the thickness of the vesical wall, infiltrated with tumor, is not more than 1 cm.; consequently, one can invariably obtain a planar implant. In making such an implant it is important to free up the bladder on the outside of the tumor, so that the sutures can be placed as near the outside surface of the bladder as possible. The object is to destroy the actively invading cells and to disregard the main tumor mass.

In freeing up the involved portion of the bladder, I have often been impressed by the fact that the tumor is much larger and more extensive than one would have guessed by seeing and feeling it from the inside of the bladder only. This observation explains why, many years ago, when I used low intensity radium needles or radium emanations, I was not always able to control the tumor. The reason now is obvious—working from the inside of the bladder, one could only guess but could not know for certain how much tumor there was.

In 1945 Brent Wayman[3] introduced a new way of using radium needles in the treatment of carcinoma of the bladder. By inserting the needles from the outside of the bladder, he destroyed the tumor where it was invading normal healthy tissue, disregarding the large fungating mass that was growing within the lumen of the blad-

Fig. 2.—Postoperative roentgenogram showing CO60 pattern. Note biplanar implant used in this case.

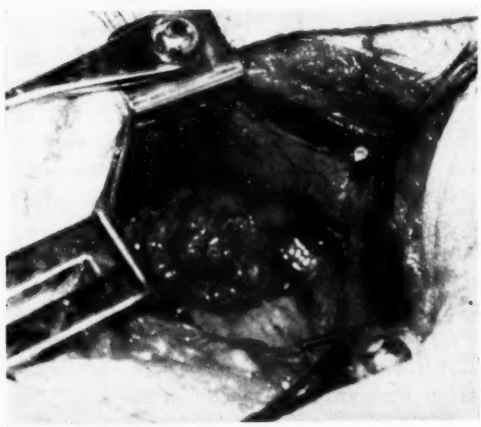

Fig. 3.—Photograph showing large sessile tumor adjacent to ureteral orifice. Protruding mass was excised, and CO60 was sutured into base of tumor, with disregard of ureteral orifice. Patient still well three and one-half years after operation.

der, where it could do no harm. My primary object, like Wayman's, is to destroy the tumor where it is actively growing into normal tissue. For that reason I never attempt to do a transurethral resection of an infiltrating carcinoma of the bladder. Unless one knows that one can actually resect all of the vesical wall that is involved in the tumor, including the few distant invading cells, an attempt at transurethral resection will often be futile.

The object of using radioactive cobalt in nylon sutures in treating this lesion, therefore, is to destroy the tumor at its periphery, where it is actually invading the tissue. The main bulk of the tumor, that which is visible cystoscopically, matters little. Only the cells at the periphery of the growth, the cells that are actually invading the tissue, are important. If a barrier can be placed at that point, what happens to the main bulk of the tumor is of no serious consequence, as it is relatively harmless. Whether it sloughs off or is removed by diathermy at the time of the surgical intervention makes little difference.

This situation is comparable to that in a case I observed a few years ago. A Wilms tumor filled half the abdomen of an infant. The tumor measured about 15 cm. in length and 10 cm. in diameter. Roentgen ray therapy caused the mass to shrink to such an extent that when I removed it, six weeks later, it did not measure quite 3 by 4 cm. On section one could barely identify tumor cells with the microscope. The bulk of the tumor was completely destroyed; but along the periphery, where the circulation was good, a few scattered, actively growing tumor cells could be seen. The identical situation occurs, at times, after segmental resection of a vesical tumor or after transurethral resection. Too frequently, after removal of the bulk of tissue, a few live carcinoma cells are left; no barrier has been placed, and the effort has been futile.

It is this basic fact that forced upon urologists the performance of total cystectomy, and it is the same basic knowledge that makes one realize that with radioactive cobalt in nylon sutures used as a planar implant one has a source of radiation that can and does furnish a carcinocidal dose to a localized area more readily and more accurately than it can be delivered by any other method.

By employing interstitial radiation—using flexible nylon sutures containing radioactive cobalt—one achieves the same result one obtains by total cystectomy, with the great advantage that the patient is left with a normal urinary tract instead of a cloaca or the necessity of using some "device."

SUMMARY

An analysis of 22 cases of vesical tumor treated, up to the time of writing, with radioactive cobalt (CO60) is presented, and illustrative cases are briefly reviewed. As a result of these experiences it has become evident that carcinoma of the bladder should be divided into three main categories for the purpose of treatment. By the use of interstitial radioactive cobalt in the treatment of infiltrating carcinoma of the bladder one can achieve the same result as by total cystectomy, with the great advantage that the patient is left with a normal urinary tract instead of a cloaca or the necessity of wearing some "device."

Author's Note: The major part of this work was done in association with the Drs. Maxfield, radiologists of Dallas. Without their help, encouragement and knowledge of radio-isotope therapy I should have been unable to obtain such apparently satisfactory results.

ZUSAMMENFASSUNG

Es liegt ein Bericht über 22 mit radioaktivem Kobalt (Co^{60}) behandelter und bis zur Niederschrift der Arbeit beobachteter Blasengeschwülste mit kurzer Dar-

stellung von erläuternden Fällen vor. Der Verfasser kommt zu dem Ergebnis, dass auf Grund dieser Erfahrungen der Blasenkrebs für therapeutische Zwecke in drei Hauptklassen eingeteilt werden sollte. Durch interstitielle Anwendung radioaktiven Kobalts in der Behandlung des infiltrierenden Blasenkrebses lassen sich dieselben Resultate wie mit totaler Blasenresektion erzielen, nur mit dem grossen Vorteil, dass der Kranke statt mit einer Kloake mit einem normalen Harnapparat davon kommt und keine "Apparaturen" zu tragen braucht.

RÉSUMÉ

L'auteur présente une analyse de 22 cas de tumeurs vésicales traitées au moyen de cobalt radioactif (COBO), analyse illustrée de quelques exemples précis. Il s'est avéré que le carcinome de la vessie devrait, pour son traitement, être divisé en trois catégories principales.

L'utilisation de cobalt radioactif interstitiel dans le traitement du carcinome infiltrant de la vessie donne le même résultat que la cystectomie totale, avec, en plus, l'avantage pour le malade de conserver un tractus urinaire normal.

SUMARIO

O A. apresenta uma análise de 22 casos de tumores vesicais tratados até o momento com o cobalto radioativo (COBO), fazendo uma revisão sumário dos casos. Como resultado diz que se torna evidente ser o carcinoma da bexiga classificável em 3 categorias principais quanto ao tratamento. Pelo uso de cobalto radioativo intersticial no tratamento do carcinoma infiltrativo da bexiga atinge-se ao mesmo resultado que com a cistectomia, com a vantagem, porém, de que o paciente permanece com seu trato urinário normal em vez de possuir uma cloaca ou ter que se utilizar de artificios.

RESUMEN

Un analisis de 22 casos de tumor vesical tratados hasta la fecha del presente articulo con cobalto radioactivo (COBO) se presenta, y casos ilustrativos se revisan ligeramente. Como reultado de estas experiencias resulta evidente que el carcinoma de la vejiga debe dividirse en tres categorias principales para proposito de tratamiento. Con el uso del cobalto radioactivo en el tratamiento infiltrante de la vejiga pueden lograrse los mismo resultados que con cistectomía total, la gran ventaja es el paciente queda con un tracto urinario normal en vez de una cloaca o la necesidade de usar algun aditamento.

REFERENCES

1. Vermooten, V.: Use of Radioactive Cobalt (CO60) in Treatment of Bladder Tumors, J. Urol. 75:85-92 (July) 1955.

2. Vermooten, V., and Maxfield, J. G. S.: Use of Radioactive Cobalt in Nylon Sutures in the Treatment of Bladder Tumors: Technique and Case Reports, J. Urol. 74:767-776 (Dec.) 1955.

3. Wayman, T. B., and Marting, E. C.: A New Method of Treatment of Infiltrating Carcinoma of the Urinary Bladder, Texas State J. Med. 40: 463-469 (Jan.) 1945.

Orthostatic Renal Hypertension Resulting from Torsion and Ptosis of the Kidney

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MANY clinical and experimental contributions have been recorded since Goldblatt performed his epoch-making experiments on renal hypertension caused by ischemia resulting from pressure on renal arteries. For many years we have observed amelioration or complete relief of orthostatic renal hypertension following nephropexy. We wish to emphasize the rôle of lesions of the vascular pedicle itself resulting from acquired torsion and ptosis of the kidney in which ischemia is due to twisting, angulation, elongation or compression of the renal vessels. Recent observation of a patient in whom orthostatic renal hypertension was spectacularly relieved by detorsion and nephropexy prompts us to offer this paper.

Concomitant sclerosis and aneurysm of the renal artery and its branches, which cause ischemia, may be contributing factors, since they may interfere with the renal blood supply which releases the pressor substance, renin.

The rôle of primary parenchymal disease in the pathogenesis of renal hypertension has been emphasized, viz., atrophic pyelonephritis, glomerulonephritis, renal hypoplasia, tuberculosis, constricting perinephritis, hydronephrosis and polycystic renal disease. In February 1956 we reported 56 cases of diminutive kidney (atrophic pyelonephritis and hypoplasia); 12 of the patients were nephrectomized because of hypertension, and there was complete relief in 6 instances.

The contribution of hydrodynamics to the production of intrapelvic hypertension is receiving considerable attention. This type of hypertension is associated with obstructive lesions of both the upper and the lower portions of the urinary tract: prostatic hypertrophy, ureteral stone and stricture, contracture or valve formation of the ureteropelvic outlet, and torsion and ptosis of the kidneys.

REPORT OF CASE

Mrs. H. U., aged 59, entered St. Mary's Hospital on April 25, 1952, with dull pain in the right lower abdominal quadrant and in the lumbar region, frequency of urination, dysuria and headaches. For three years she had been treated (elsewhere) for essential hypertension.

The blood pressure in millimeters of mercury was 220 systolic and 100 diastolic. Forty-five per cent of the injected phenolsulfonephthalein had been excreted by the end of the second hour. The urine was clear, with a specific gravity of 1.022, and gave negative reactions for albumin and sugar. There were 4 to 6 leukocytes and an occasional erythrocyte per high power field.

Cystoscopic study revealed numerous infected polyps on the vesical neck, which were destroyed by fulguration on April 28. The progress of a No. 8 bulb catheter inserted into the right ureter was arrested 20 cm. above the orifice; while the patient was being placed in the exaggerated Trendelenburg position, however, the catheter passed into the renal pelvis, indicating a kink of the ureter. In two and one-half minutes, indigo carmine injected intravenously appeared from both kidneys in good concentration.

Bacillus alkaligenes was cultured from the

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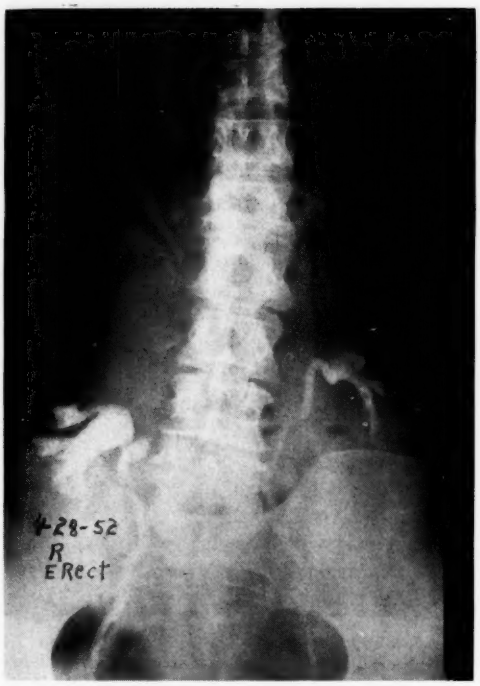

Fig. 1.—Retrograde pyelogram taken with patient in erect position. Note torsion and ptosis of both kidneys, more marked on right, and dilation of right renal pelvis.

urine collected from both kidneys. Retrograde pyelographic study revealed right hydronephrosis, torsion and third degree ptosis of the right kidney and moderate torsion and ptosis of the left kidney (Fig. 1). Fifteen-minute after-films revealed retention in both renal pelves, more marked on the right. The results of physical examination and the laboratory data otherwise were within the normal range.

On May 8 detorsion, sympathectomy and nephropexy were performed on the right kidney, which was low in the iliac fossa and rotated on its horizontal axis, with twisting of the vascular pedicle. The kidney presented cicatricial areas and small cysts on its convex surface. The renal artery was sclerotic.

Recovery was uneventful, and the patient's blood pressure in millimeters of mercury fell to 160 systolic and 100 diastolic. Thereafter she was examined monthly, and the blood pressure remained stabilized for two years.

In April 1954 the blood pressure rose to 200 systolic and 100 diastolic and she complained of pain in the upper left quadrant of the abdomen and the lumbar region. On May 4 urologic examination, including retrograde pyelographic studies, revealed the right kidney to be in good position, but torsion of the opposite kidney was increased (Fig. 2). On May 19 detorsion and nephropexy were performed on the left kidney, which was quite low and rotated on its horizontal axis, with twisting of the renal pedicle. The pelvis was enlarged, but retrograde passage of a bulb catheter at the time of operation failed to reveal intrinsic ureteropelvic obstruction. A small saccular aneurysm of the renal artery was encountered, but since it was not advanced the kidney was not sacrificed. The fibrosis that usually takes place during healing was relied on to reinforce the defect in the arterial wall.

After the second operation the blood pressure fell again. Monthly postoperative examinations have showed that it has remained at or below 160 systolic and 100 diastolic.

On Nov. 22, 1955, a follow-up urologic examination, including retrograde pyelographic studies, revealed both kidneys in normal position and regression of hydronephrosis (Fig. 3). In two minutes after intravenous injection, indigo carmine appeared in good concentration from both kidneys. By the end of the second hour, 52 per cent of the injected phenolsulfonephthalein was excreted. At the time of writing the patient is enjoying good health and is symptom free.

By way of comment and comparison, we observed, in 1951, a woman 56 years old whose hypertension and severe left renal colic was relieved by detorsion, removal of cysts and suspension of the left kidney. Four years later (1955) renal colic developed in the right kidney and the hypertension recurred, associated with torsion and ptosis. In March 1955 detorsion and nephropexy were performed on the right kidney, with amelioration of the high blood pressure. Four months later, however, at the age of 61, the patient died of a cerebral accident. Apparently the associated hypertensive cardiovascular disease played a rôle in the final outcome.

Historical Notes.—In 1908 Albarran pointed out that in most cases of advanced renal ptosis, varying degrees of torsion

were also present. In 1915 Labey and Paris observed that when the congenital, incompletely rotated kidney became mobile, displacement occurred on its transverse axis. In 1923 Baggio called attention to the danger of failing to recognize anomalous rotation when ptosis is present. In 1934 de la Peña and Raguz commented on the difficulty of making a roentgenographic diagnosis of acquired or congenital torsion. In 1948 Prather described the new renal syndrome of medial ptosis, in the presence of which elongation of the vascular pedicle might well cause ischemia and renal hypertension.

Papin in 1938 and Weyrauch in 1939 reported extensive studies on the anomalies of renal rotation.

In 1938 Schroeder and Steele observed 2 cases of unilateral hydronephrosis associated with ptosis in a series of 71 cases of essential hypertension.

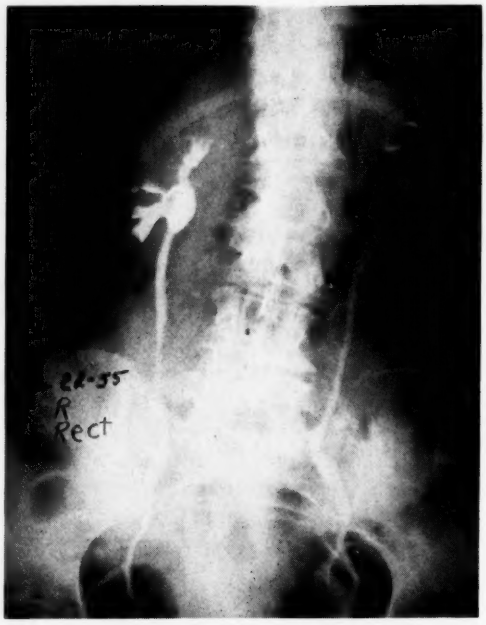

Fig. 3.—Retrograde pyelogram with patient in erect position. Note normal position of kidneys and regression of hydronephrosis (after bilateral detorsion and nephropexy).

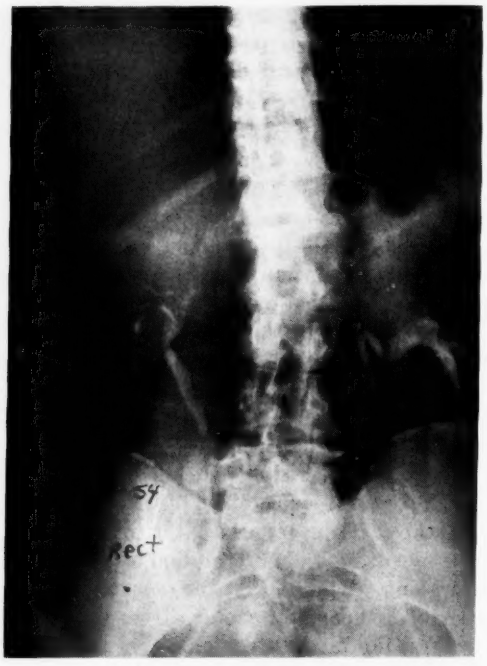

Fig. 2.—Retrograde pyelogram with patient in erect position. Note normal position of right kidney after detorsion and nephropexy. Left kidney still presents torsion and ptosis.

In 1940 McCann and Romansky studied, in detail, orthostatic renal hypertension due to nephroptosis. They suggested appropriate treatment, surgical or supportive, for orthostatic hypertension due to ptosis. Abeshouse, in 1940, in an excellent monograph, completely classified the types of renal disease that may cause unilateral renal hypertension, including ptosis and torsion. In 1941 Hines and Lander called attention to the rôle of heredity in the development of renal hypertension.

Etiologic Factors.—We are concerned mostly with acquired renal torsion. Renal hypertension is less likely to accompany congenital renal rotation, as the vascular changes due to mechanical factors affecting the pedicle are usually absent. In the presence of congenital torsion the kidney

usually rotates on its vertical or anteroposterior axis; in the presence of acquired torsion, on its horizontal axis.

In a recent paper on the relation of trauma to nephroptosis we enumerated the most common mechanical etiologic factors: the erect position of man, peculiarity of body form, lack of muscle tone, diminished intra-abdominal pressure and inherent weakness of the supporting renal and perirenal fascia. In the normal adult there is slight upward convergence of the vertical axes of the kidneys, as the lower poles are displaced laterally by the iliopsoas muscle and the upper poles medially by the liver and spleen. The iliopsoas muscle mass causes an oblique backward shift of the horizontal axis to form a 40-degree angle with the midline of the body. As the kidney begins to descend it remains in its vertical position, but as the downward displacement increases the organ is held back by the vascular pedicle, which causes it to rotate on its horizontal axis (Fig. 4). When the upper pole is displaced backward and the inferior pole forward, the kidney takes on an oblique position. The degree of torsion depends on the length and attachment of the pedicle. The prolapsed kidney exerts traction, elongating, narrowing or compressing the vascular pedicle. Superimposed torsion may actually twist the renal vessels, constricting the renal artery and thereby causing ischemia. Renal torsion can also be caused by retroperitoneal tumor, perinephritic abscess, tumefaction of the liver and spleen, or intrinsic renal masses.

Hydrodynamics may also be a contributing factor. Increased intrapelvic pressure, which results from obstruction due to kinking of the upper portion of the ureter, is caused by ptosis of the kidney. In turn, the resultant increased intrapelvic pressure may compress and constrict the vascular pedicle itself. Davis recently pointed out that, in many cases, pelvic hypertension can be corrected by operation.

Urologists with wide experience in the surgical correction of nephroptosis have observed that nephropexy relieved hypertension in certain patients (Abeshouse, Ritch and others). We, too, have observed this phenomenon for many years.

In 1940 McCann and Romansky made interesting observations on orthostatic hypertension. In studying hypertensive patients with nephroptosis, they made pyelograms with the patient in the recumbent and in the erect position and observed the effect of posture on blood pressure, glomerular filtration rate and renal blood flow. They utilized the inulin clearance test of Smith and his colleagues to determine the glomerular filtration rate and the diodrast test of White and Rolf to determine the total flow of renal plasma. In some patients with nephroptosis the erect position caused orthostatic hypertension, which resulted from diminution of the renal blood flow and relative constancy of glomerular infiltration. They noted that when ptosis and torsion were present the erect position caused traction on the pedicle, resulting in elongation, narrowing, compression or constriction of the renal vessels. This interferes with the afferent blood supply of the kidney which leads to the production of renin; renin, in turn, constricts the vasa efferentia of both kidneys, resulting in ischemia due to decrease of the total blood flow. The glomerular filtration rate remains relatively constant because of the compensatory effect of increased intraglomerular pressure. The authors made these deductions from detailed studies of 5 cases of orthostatic hypertension due to nephroptosis. Nephropexy was carried out in 1 case of advanced malignant hypertension, and, although the blood pressure remained elevated, it was somewhat diminished after the operation. There was sympto-

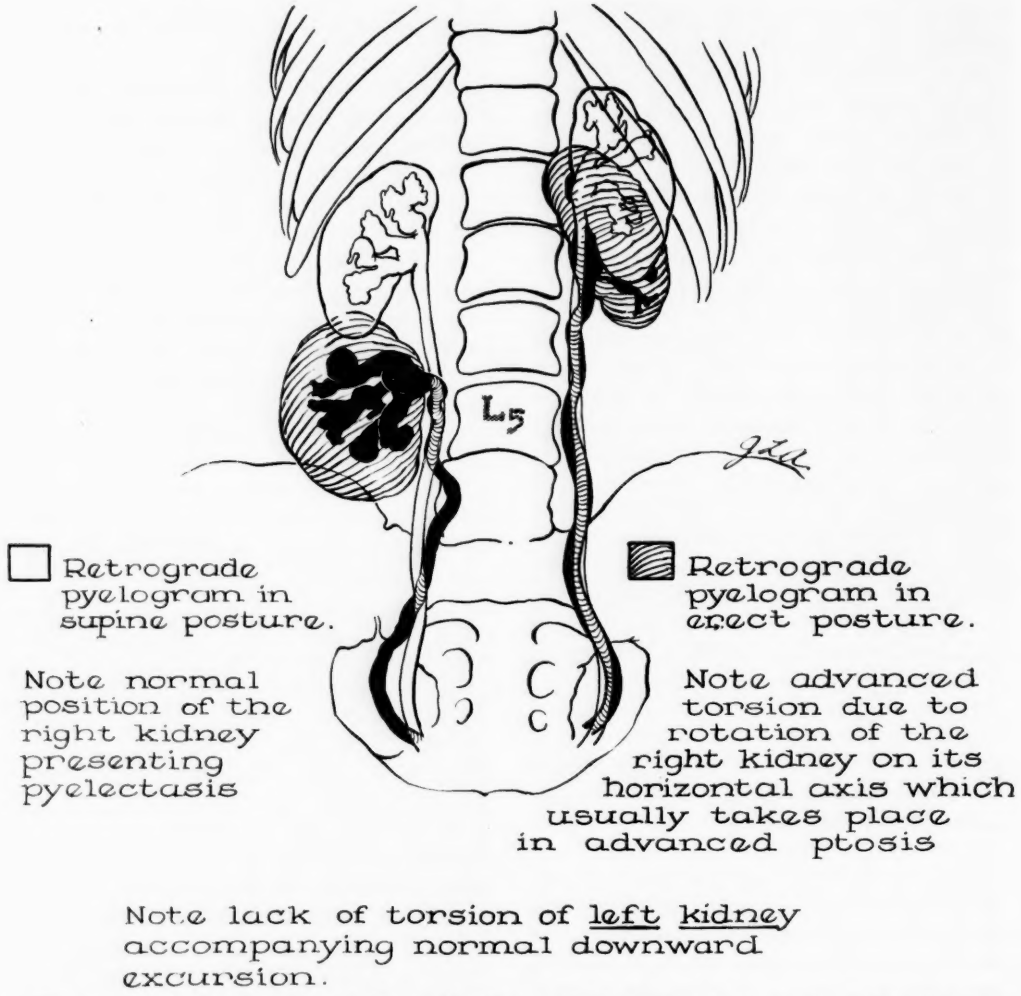
L5
Retrograde pyelogram in supine posture.
Note normal position of the right kidney presenting pyelectasis
Retrograde pyelogram in erect posture.
Note advanced torsion due to rotation of the right kidney on its horizontal axis which usually takes place in advanced ptosis
Note lack of torsion of left kidney accompanying normal downward excursion.

Fig. 4.—Artist's sketch showing pyelographic effects with the patient in the supine and in the erect position (*see text*).

matic improvement, with disappearance of episodic cardia, cerebral and ocular symptoms. McCann and Romansky emphasized the fact that nephroptosis is not accompanied in all cases by orthostatic hypertension, and advised appropriate surgical or supportive treatment when nephroptosis is found to be the etiologic factor.

In most patients, movable kidney *per se* causes no symptoms. In some instances of nephroptosis, however, interference with the blood supply, due to stasis from back pressure or to twisting of the renal blood vessels as a result of renal ptosis and torsion, leads to orthostatic hypertension.

Hines and Lander pointed to heredity as a contributing factor in the development of hypertension in patients suffering from renal disease. They made a detailed study of 264 patients suffering from some

sort of renal disease. They noted that patients whose blood pressure was high at the first examination were more likely to become hypertensive eventually, regardless of the type of renal disease encountered. This may explain why only some patients with nephroptosis and torsion, as well as others with various kidney lesions, acquire hypertension.

COMMENT

Hypertension is of great interest to the physician, as it occurs in approximately 24 per cent of the adult population. The diagnosis of essential hypertension should not be hastily made. One should always bear in mind that hypertension in many cases is of renal origin (50 of the 71 cases recorded by Schroeder and Steele). Blackman observed arteriosclerotic changes in the renal arteries of 43 of 50 patients with essential hypertension. The main causes of renal ischemia leading to hypertension are atrophic pyelonephritis, hypoplasia, glomerulonephritis, constricting perinephritis, atheroma or aneurysm of the renal artery and various obstructive conditions of the urinary tract. In making a comprehensive examination of the entire body, a complete study of the urinary tract should be made. In order to detect orthostatic renal hypertension in the search for etiologic renal disease, examination should include anteroposterior and lateral pyelograms taken with the patient in the supine and erect positions. When nephroptosis is detected in a patient with hypertension, the blood pressure should be measured during ordinary activity and also after strict recumbency. If the pressure is 40 to 50 mm. lower after enforced recumbency, one may conclude that orthostatic renal hypertension is present. This may be accompanied by sclerotic vascular changes in the brain, heart, eyes and urinary bladder.

In treating the offending ptotic kidney that presents varying degrees of torsion one should consider surgical intervention. We fully realize that in a few instances symptoms can be relieved by supportive belts. For most patients, however, detorsion and nephropexy are the only remedy. In the treatment of orthostatic hypertension this operation is always indicated for an obese patient, a patient with extensive abdominal scars, a patient in whom the kidney is anchored in an unusually low position owing to perinephritis or one who is not relieved by conservative measures. Long experience has revealed the efficacy of nephropexy in the treatment of patients with the classic symptoms of nephroptosis (pain, gastrointestinal distress and nervous phenomena). It is equally effective for patients in whom nephroptosis causes orthostatic renal hypertension.

About two years must elapse after detorsion and nephropexy before a conclusion should be reached that a ptosed and twisted kidney *per se* is the cause of hypertension. Recurrence is least frequent in patients under 45 years of age and in those in whom hypertension is of short duration. In some of our patients, although the blood pressure did not return to normal, it was stabilized at a lower level than before the operation. In some cases of orthostatic renal hypertension, cerebral, ocular and cardiac symptoms were ameliorated or relieved by stabilizing the blood pressure.

SUMMARY

1. In a number of cases, "essential hypertension" is of renal origin.

2. In a comprehensive examination of the body of the hypertensive patient, a complete study of the urinary tract should be included.

3. Renal ptosis with torsion of the kidney should be included among etiologic

renal diseases, as it may cause orthostatic renal hypertension.

4. In searching for etiologic orthostatic renal hypertension, the blood pressure should be measured during ordinary activity and after strict recumbency, at which time it should be 30 to 40 mm. lower. Anteroposterior and lateral pyelograms should be taken with patient in both the supine and the erect position.

5. In most patients, renal ptosis and torsion cause no symptoms; in some instances, however, the erect position may cause interference with the blood supply because of stasis due to back pressure or twisting of the renal blood vessels, thus resulting in orthostatic hypertension.

6. Renal ischemia resulting from a decrease in the blood flow is brought about by elongation, narrowing, compression or constriction of the vascular pedicle.

7. Detorsion and nephropexy have relieved patients suffering from orthostatic hypertension due to torsion and ptosis of the kidney. In some, although the blood pressure did not return to normal, the hypertension was less severe. In others, the overshadowing cerebral, ocular and cardiac symptoms were ameliorated by stabilizing the blood pressure at a lower level by fixation of the kidney in a high position.

ZUSAMMENFASSUNG

1. Der "essentielle Hochdruck" ist in einer Reihe von Fällen auf renalen Ursprung zurückzuführen.

2. Eine umfassende Untersuchung des Hochdruckpatienten sollte eine vollständige Untersuchung des Harnapparates einschliessen.

3. Zu den ursächlichen renalen Erkrankungen gehören die Senkung und Drehung der Niere, die einen orthostatischen renalen Hochdruck hervorrufen können.

4. Beim Studium der Möglichkeit eines orthostatischen renalen Hochdrucks als Krankheitsursache müssen Blutdruckmessungen sowohl während normaler Aktivität als auch nach absoluter Ruhelage vorgenommen werden; im letzteren Falle können Werte erwartet werden, die 30 bis 40mm unterhalb der bei Aktivität gewonnenen liegen. Anteroposteriore und seitliche Pyelogramme sollten sowohl in Rückenlage als auch bei aufrechter Stellung des Kranken angefertigt werden.

5. Senkung und Drehung der Niere verursachen in den meisten Fällen keine Krankheitserscheinungen; manchmal aber kann die aufrechte Stellung durch Rückstauung oder durch Knickung der Nierengefässe zu einer Verlangsamung des Blutstromes und zur Behinderung der Blutversorgung der Niere führen mit dem Resultat eines orthostatischen Hochdrucks.

6. Eine durch Verminderung der Blutzufuhr bedingte Blutleere der Niere kann durch Streckung, Verengung, Zusammendrückung oder Einschnürung des Gefässstieles hervorgerufen sein.

7. Behebung der Nierendrehung und Nephropexie haben zur Beseitigung der Beschwerden von Kranken mit orthostatischem Hochdruck als Folge von Torsion und Ptose der Niere geführt. In manchen Fällen wurde zwar nicht eine Rückkehr des Blutdrucks zur Norm aber doch eine Senkung erzielt. In anderen Fällen besserten sich die im Vordergrund des Krankheitsbildes stehenden Gehirn-, Augen- und Herzsymptome durch Stabilisierung des Blutdrucks auf einem niedri-

geren Niveau nach Fixierung der Niere in einer höheren Lage.

RÉSUMÉ

1. Dans de nombreux cas l'hypertension essentielle est d'origine rénale.

2. L'examen de tout malade hypertendu devrait comprendre aussi une étude complète du système urinaire.

3. Il faut songer également à la ptose et à la torsion du rein comme facteurs étiologiques de l'hypertension rénale orthostatique.

4. Lors de la recherche étilogique d'une hypertension rénale orthostatique, il est indiqué de mesurer la pression sanguine, aussi bien en état d'activité normale qu'en position couchée, moment auquel elle devrait être abaissée de 30 à 40 mm. Il faut de plus pratiquer des pyélogrammes antéro-postérieur et latéral, en position debout et en position de supination.

5. La ptose et la torsion rénales ne produisent en général pas de symptôme; dans certains cas cependant, la position debout peut créer des troubles de la circulation sanguine, provoqués par la stase due à la pression postérieure ou à la torsion des vaisseaux sanguins rénaux, aboutissant ainsi à une hypertension orthostatique.

6. L'ischémie rénale résultant d'une diminution de la vascularisation sanguine est produite par l'élongation, le rétrécissement, la compression ou la constriction du pédoncule vasculaire.

7. Les malades atteints d'hyptertension orthostatique due à la torsion et à la ptose, ont été soulagés par la détorsion et par la néphropexie. Dans quelques cas, bien que la pression sanguine ne soit pas retournée à la normale, l'hypertension a diminué. Dans d'autres cas, les symptômes cérébraux, oculaires et cardiaques, qui couvrent le tableau de l'affection, ont été améliorés par l'abaissement et la stabilisation de la pression sanguine grâce à une fixation haute du rein.

SUMARIO

1. Em muitos casos a "hipertensão essencial" é de origem renal.

2. Um estudo completo deve ser feito durante o exame clínico do paciente portador de hipertensão.

3. A ptose e a torsão renais devem ser incluidas entre as causas etiológicas pois que podem causar hipertensão renal ortostática.

4. Na pesquiza da hipertensão renal ortostática as medidas da pressão arterial devem ser feitas no curso da atividade normal e depois de completo repouso, ocasião em que devem os valores se apresentar com 30 a 40 mm. mais baixos. As pielografias antero-posterior e lateral devem ser realizados com o paciente em decubito e de pé.

5. Em alguns casos a ptose e a torsão renais são assintomáticas; pode ocorrer, porém, que a posição erecta determine alterações tensionais porque a estase devida a pressão ou a torsão dos vasos renais resulta em hipertensão ortóstatica.

6. A isquemia renal consequente a diminuiçã do suprimento sanguineo é causada pelo estiramento, estreitamento, compressão ou constricção do pedículo vascular.

7. A distorsão com nefropexia tem aliviado os pacientes portadores de torsão e ptose renais. Em alguns casos não há retorno da P.A. aos níveis normais porém a hipertensão será menos grave.

Em outros doentes a sintomatologia cerebral, ocular e cardíaca é influenciada com estabilização da P.A. em nível mais baixo quando se fixa o rim numa situação elevada.

RESUMEN

1. En un buen número de casos la hipertensión esencial es de origen renal.

2. En un Concienzudo examen del cuerpo del paciente jipertenso, un estudio completo del tracto urinario debe ser incluido.

3. La ptosis y torsion de el riñón deben ser incluidos entre el origen de las enfermedades renales, según esto puede causar hipertension ortostática renal.

4. En la investigación etiológica de la hipertension ortostática renal, la presion arterial debe ser tomada durante las actividades ordinarias y después de estricto reposo, en tal momento deberá ser de 30 a 40 mm. mas baja. Los pielogramas en posicion anteroposterior y lateral deberan ser tomados con el paciente en posición supina y erecta.

5. En la mayoría de los pacientes, la ptosis y torsion renal no producen síntomas, algunas veces sin embargo, la posicion erecta puede interderir con el abastecimiento sanguineo causa de estasicamiento debido a caida de la presion o torsion de los vasos renales, resultando así en hipertension ortostática.

6. Isquemia renal resultado de una disminución en el fluido sanguineo es producida por elongacion adelgazamiento, compresion o constriccion de el pediculo vascular.

7. Destorsion y nefropexia han ayudado a pacientes que sufren de hipertension ortostática debido a torsion y ptosis del riñon. En algunos, aunque la presion sanguinea no regresó a lo normal, la hipertensión fue menor severa. En otros los síntomas aminosados de cerebral, ocular y cardiaco fueran aminorados por la estabilización de la pression sanguinea a un nivel más bajo por finjacion del riñon en una posicion alta.

BIBLIOGRAPHY

Abeshouse, B. S.: Hypertension and Unilateral Renal Disease, Surgery **9**:942 and **10**:147, 1941.

Albarran, J.: Médecine Opératoire des voies urinaires. Paris: Masson et Cie, 1908, p. 102.

Baggio, G.: L'ectopia del rene nella regione lombare, Policlin. **30**:605, 1923.

Blackman, S. S. Jr.: Arteriosclerosis and Partial Obstruction of the Main Renal Arteries in Association with "Essential" Hypertension in Man, Bull. Johns Hopkins Hosp. **65**:353, 1939.

Davis, D. M.: The Hydrodynamics of the Upper Urinary Tract, Ann. Surg. **140**:839, 1954.

Goldblatt, H.; Lynch, J.; Hanzel, R. F., and Summerville, W. W.: Studies in Experimental Hypertension, J. Exper. Med. **59**:347, 1934.

Hines, E. A. Jr., and Lander, H. H.: Factors Contributing to the Development of Hypertension in Patients Suffering from Renal Disease, J.A.M.A. **116**:1050, 1941.

Labey, G., and Paris, J.: Rein ectopique congénital pris pour une tumeur du Mésentère, J. d'urol. **5**:769, 1914.

Mathé, C. P.: Etiologic Role of Trauma in Nephroptosis, Am. J. Surg. **88**:559, 1954.

Mathé, C. P.: The Diminutive Kidney, California Med. **84**:110, 1956; Le Petit Rein, Tr. Assoc. Franc. d'urol. 49e Congrès Français 1954.

McCann, W. S., and Romansky, M. J.: Effect of Ptosis of Kidneys on Blood Pressure, Renal Blood

Flow and Glomerular Filtration, Tr. A. Am. Phys. 55:240, 1940.

McCann, W. S.: Orthostatic Hypertension: Effect of Nephroptosis on Renal Blood Flow, J.A.M.A. 115:573, 1940.

Papin, E.: Chirurgie du rein. Paris: G. Doin et Cie, 1928, vol. 1, p. 191.

De la Peña, A., and Raguz, R.: Torsion rénale congénitale, J. d'urol. 38:13, 1934.

Prather, G. C.: Medial Ptosis of the Kidney: New Renal Syndrome, New England J. Med. 238: 253, 1948.

Ritch, C. O.: Urological Lesions Masked as Essential Hypertension, Illinois M. J. 70:74, 1936.

Schroeder, H. A., and Steele, J. M.: Abnormalities of Urinary Tract in "Essential Hypertension," Proc. Soc. Exper. Biol. & Med. 39:107, 1938.

Weyrauch, H. M.: Anomalies of Renal Rotation, Surg., Gynec. & Obst. 69:183, 1939.

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Neurologic Surgery

Craniocerebral Injuries and the Postconcussion Syndrome

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SINCE my early association with the Los Angeles General Hospital, where I had occasion to treat over 20,000 patients with accidental injuries—the incidence of man-made injuries to the head has filled me with horror. As the miracle of our push-button mechanized civilization progresses, the incidence of preventable injuries to the head is increasing beyond belief.

The average person is not physiologically equipped with adequate corticospinal reflex response necessary for the operation of our modern, sensitive vehicles, especially under emergency circumstances.

Our superdeluxe, block-long pink and lavender racing cars, instead of being a source of comfort and pride, are actually potentially lethal weapons, comparable to pearl-handled machine guns. The result of this is 40,000 deaths and 1,000,000 disablements in the United States every year. It is well known that the death rate from accidental injuries during times of alleged peace exceeds, to appalling proportions, the death rate from modern catastrophic war.

The neurosurgeon's daily concern is with the eritically injured patients. The survival of every such patient depends entirely on proper diagnosis and proper management; i.e., on the knowledge, the judgment and, above all, the conscience of the *first* doctor who is called to the bedside.

Who Shall Treat Craniocerebral Injuries? No two accidents ever produce exactly identical injuries; therefore, the physician who brings to the bedside of the unconscious patient a page from a textbook is inviting disaster.

One can train experts only by teaching students to observe and to think. The family physician can contribute much to the general metabolic state in the recovery period, and once the emergency is past the greatest thing that can be done for the general practitioner is to alert him to the danger signals.

A wise general practitioner is grateful when the neurosurgeon carries the responsibility at this stage. There are no rules, no mathematical calculations of symptoms that will add up to the diagnosis. This is a changing picture, and the surgeon must be ever receptive to the constantly changing messages transmitted to him by the patient. The unconscious patient communicates only with the expert.

Extensive and brilliant contributions have been made to the treatment and survival of the patient with a critically injured head. These include optimal management of the unconscious patient, the importance of good respiratory exchange, the proper balance of fluid, protein and electrolytes, the detection of associated visceral injury and the diagnosis of sur-

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gical hematomas both in the anterior and in the posterior fossa. Nevertheless, many a patient with cerebral concussion, an injury less dramatic than many others and carrying little or no threat to life is neglected by the general practitioner and the specialist alike. As a result, many a patient in whose case only the diagnosis of cerebral concussion has been made remains incapacitated by severe headaches for months or even years.

The purpose of this communication, therefore, is to clarify and evaluate the much maligned symptom complex loosely termed "the postconcussion cerebral syndrome."

A patient with this syndrome, some weeks after injury, may be quite normal as judged by gross neurologic tests; he may have a normal electroencephalogram; roentgenogram of the skull and tests of the spinal fluid may give negative results, and even the pneumoencephalogram may be normal; yet the patient complains of severe headaches and exhaustion, as well as inability to return to his usual duties. In the courts of law such persons are often accused of malingering or of having a "litigation neurosis."[2]

The symptom complex following many cerebral concussions *consists of two major factors:* (1) bouts of severe headache or hemicrania, and (2) the syndrome of vasomotor (neurocirculatory) exhaustion.

The headaches, often severe, may begin in the suboccipital area, radiating to the vertex and at times to the area behind one eye. In other cases the pains are frontal and temporal, extending over the vertex to the occipital area.

Analysis of the symptoms of several thousands of such patients will reveal that headaches persisting for months or years after a cerebral concussion are *real* and that they are *extracranial* in origin. The headaches stem primarily from two sources: (1) the upper cervical-spinal nerve roots and (2) elements of the trigeminal nerve. Alternately, a combination of the two may exist.

Before going into greater detail, I wish to introduce a new term that describes and encompasses the complex of symptoms that follows injuries to the head and neck. My new term is *craniocervical syndrome.*

The Role of Cervical Trauma.—A patient who incurs concussion while riding in a moving vehicle always undergoes some degree of *cervical sprain,* and the vast majority of those with whiplash injuries of the neck have some degree of cerebral concussion[3] and, most certainly, sprain of the cervical portion of the spine.

"In almost every instance of head trauma, some of the force is transmitted

Fig. 1.—Cutaneous distribution of C2 and C3. Modified from Mayfield, F. H.: Neurosurgical Aspects of Cervical Trauma, Clinical Neurosurgery 2:85, Williams and Wilkins Company, 1955.

to the structures of the neck,"[4] the only exception being penetrating gunshot wounds of the brain, especially with missiles of high velocity.[5]

In every case of accidental injury, when the head is involved in sudden acceleration or deceleration, some unnatural movement, rotation or strain has been suffered by the upper cervical spinal roots and muscles.[7]

The Role of the Upper Cervical Nerve Roots.—Mayfield described the "syndrome of the second cervical root" as a definite clinical entity. The second cervical root terminates at the great occipital nerve and supplies the major portion of the scalp, the upper part of the neck and portions of the face[1] (Fig. 1). Mayfield stated that the second cervical root is more vulnerable to trauma than other nerve roots because it is not protected posteriorly by pedicles and facets, which form the posterior half of the root canal elsewhere in the vertebral column.

The Role of the Spinal Accessory Nerve.—I should like to call attention to the anatomic aspects of the spinal accessory nerve. Except for 10 to 15 per cent, at most, the intracranial filaments take origin from the entire length of the cervical cord—always as low as the fifth and often as low as the seventh cervical level (Fig. 2).

Any acute flexion, extension or torsion of the neck will exert traction on the delicate filaments of the spinal accessory nerve, resulting in spasm of the trapezius and sternocleidomastoid muscles.

There are two additional factors in the production of pain from associated muscle spasm and cervical sprain. When the trapezius and the suboccipital muscles, including the splenius capitis and the semispinalis capitis, are in spasm, traction is produced on the great occipital nerve as it pierces the fascial attachment of these muscles. In addition, spasm of the oblique capitis inferior muscle (Fig. 3*A*) places additional traction on the great occipital nerve. It will be remembered that the second cervical root, after leaving the interspace between the first and the second cervical level, courses down and winds under the inferior border of the oblique inferior muscle before proceeding upward as the *great occipital nerve.*

Pains caused by disturbance of the second cervical root begin in the suboccipital area. They are often unilateral and may extend to the vertex, the temple, the forehead and the area behind the homolateral eye. Giddiness, unsteadiness and occasionally nausea may follow. Disturbance in focusing the eyes is complained of by some.

The cervical plexus originates from the second and third cervical and gives origin to the *great auricular nerve* and *the lesser occipital nerve,* as well as cutaneous twigs to the neck and the lower part of the face. Disturbance of the third as well as the second cervical nerve may give rise to pain over the temporal and mandibular areas.

Reichert[6] pointed out that, in addition to disturbing the upper cervical roots during neck sprain, the many muscles, together with their *paravertebral ligaments* and *fascial attachments,* are directly involved in the trauma producing muscle spasm. In his series of 78 patients with whiplash injuries, headache was the major complaint of 47.

Cervicotrigeminal and Occipital-Trigeminal Relations.—Many observers have noted sensory changes extending well over the trigeminal facial area after a whiplash injury of the neck. There are three explanations for this phenomenon:

1. *Extensive overlaps* from the upper cervical roots by way of the cervical plexus and cutaneous coli to the lower portions of the face.

2. Communications between branches of the cervical plexus (second and third cervical nerves) and the trigeminal nerves.

Some communications have been observed anatomically, others psysiologically, between the cranial and the cervical nerves.

3. *Occipital-trigeminal relations* between the great occipital (second cervical) nerve and the trigeminal nerve, by way of the spinal-fifth tract in the medulla, have been described.[8] Thus, in a recent case of occipital and facial neuralgia reported by the Industrial Accident Commission of Nevada, the patient had fallen from a 12-foot ladder and had landed on his neck and shoulder. No fractures were sustained. Thereafter occipital headaches developed, radiating to the vertex on the left side and associated with painful paresthesia and objective sensory change, specifically in the second division of the trigeminal nerve on the homolateral side. Procaine block of the occipital nerve temporarily abolished pain, and section of the occipital nerve completely eradicated the trigeminal pain.

The excellent presentation by Skillern[8] on the great occipital trigeminus syndrome is a major contribution to the understanding of post-traumatic headache: "Based on clinical findings, a synapse exists between the great occipital and trigeminal nerves. The fibers from the three divisions of the trigeminus descending in the trigeminospinal tract reach their respective levels in inverse order, the lowest being the ophthalmic, fibers of which terminate at the second cervical nerve, and therefore receive the first impulse from the great occipital nerve" (Fig. 3*B*).

Weyburn-Mason[9] described cure of major trigeminal neuralgia by alcohol block or section of the great auricular nerve. Since then others, including myself, have been able to stop third division pain, in selective cases, by blocking the great auricular nerve. Recently, in an elderly patient, after removal of a granuloma from the floor of the external auditory canal (supplied by the great auricular nerve), severe pain developed in the temple and forehead, followed by hemicranial pain. Blocking of the supraorbital nerve on the same side immediately abolished the headache and pain. Blocking of the great auricular nerve abolished the pain completely.

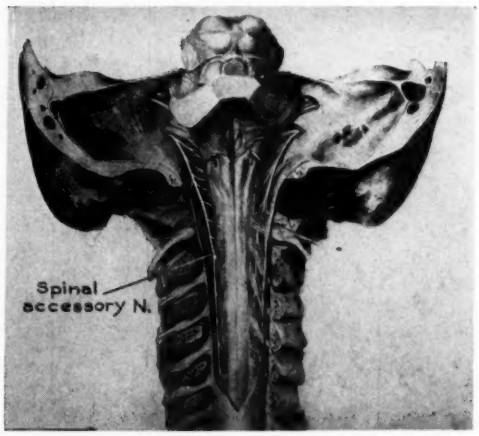

Fig. 2.—The spinal accessory nerve takes its major rootlets of origin from the entire length of the cervical spinal cord. Modified from Spalteholz, W.: Atlas of Human Anatomy. Philadelphia: The J. B. Lippincott Company. 5th ed., vol. 3, p. 727, Fig. 833.

Contusions of the Scalp.—Contusions of the scalp over the occipital or parietal area involving elements of the occipital nerve or local contusions of the frontal areas involving elements of the trigeminal nerve may give rise to bouts of severe and persistent headache. They often are undiagnosed because the patient usually complains of generalized or hemicranial headache. Careful searching, however, will disclose trigger areas over the scalp that set off the entire headache. Excision of some of these trigger areas has revealed, on histologic examination, neuromatous scar tissue. Watts, Wiley and Groh[10] observed that headache and dizziness may follow contusion of the scalp.

Such a contusion over the main occipital nerve trunk or any portion of the occipital innervation may cause severe pain from

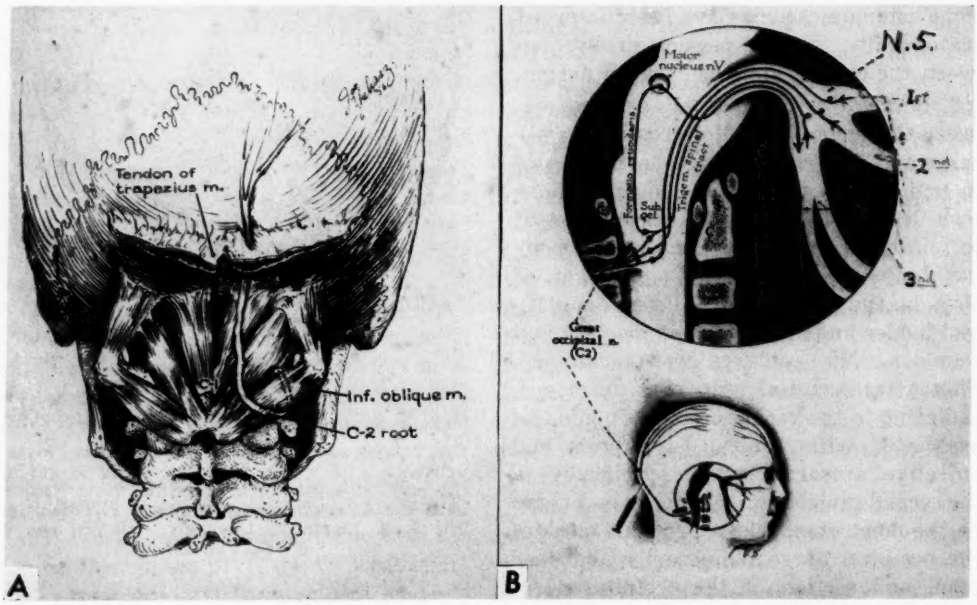

Fig. 3.—*A*, the second cervical root after leaving the C1-C2 interspace, courses down and winds under the inferior border of the oblique inferior muscle before proceeding upward (to pierce the occipital attachment of the trapezius muscle) as the great occipital nerve. *B*, synapse between great occipital nerve and trigeminal nerve. Skillern, P. G.: Great Occipital-Trigeminus Syndrome as Revealed by Induction Block, Arch. Neurol. & Psychiat. 72:335-340, 1954.

the occipital area to the vertex and to the frontal area as well. Often the pain will radiate behind the eye on the same side. Careful examination frequently discloses a minute palpable scar, pressure on which may initiate the entire migraine-like syndrome.

A 50-year-old woman was recently examined for severe migraine-like headache limited to the left side. Three years earlier a flatiron had fallen from a shelf immediately above her head and bruised the scalp near the vertex. She was not unconscious. The headaches began within two weeks after the injury. Neurologic, electroencephalographic and normal roentgen examination failed to reveal any abnormality. When the patient first appeared she had already undergone studies of the spinal fluid and a pneumoencephalographic examination, also with normal results. Palpation of the scalp revealed a slightly elevated scar, 5 mm. in diameter, at the vertex, just to the left of the midline (Fig. 4*A*). Palpation of this scar immediately produced severe hemicranial headache and pain behind the left eye. A small horseshoe incision was made about the scar. This totally abolished the pain.

Contusions over the supraorbital or the supratrochlear nerve or its branches are a common cause of frontal headache. A 17-year-old boy complained of attacks of left frontal headache of two years' duration following a cerebral concussion. Objective sensory changes were detectable by pinprick in the left frontal area, and palpation over a healed transverse scar above the left eyebrow produced severe frontal headaches (Fig. 4*B*). Procaine infiltration in this area abolished the headache.

When the innervation of the scalp is disturbed by contusion, sensory changes will be discovered if careful testing is done. In the management of intractable severe occipital headache, Mayfield and others have observed that section, primarily of the second cervical sensory root intradurally, or of the second and third, will abolish the pain. Chambers,[11] reporting on a series of 35 patients who had undergone posterior rhizotomy of the second and third cervical nerves for occipital pain, stated that in only 1 did the procedure fail to bring relief. Chambers specifically pointed out that a psychoneurotic attitude, acquired after years of pain, on the part of the patient is not a valid deterrent to surgical intervention.

The Vasomotor Exhaustion Syndrome.—It is my conviction that the incapacitating symptoms, consisting of high-headedness, giddiness, exhaustion, insomnia and a feeling of insecurity, during periods of paroxysmal tachycardia, are all due to the stress reaction. This is often noted in patients with minor injuries, even, as a rule, when there has been no unconsciousness. This group of symptoms is caused by a fright reaction brought on by the conscious experience of a near catastrophe. This reaction is related to the stress or alarm reaction followed by the exhaustion syndrome as originally described by Selye.[12] It is best illustrated and contrasted by two types of injury: (1) severe trauma with a prolonged period of unconsciousness, and (2) a narrow escape from catastrophe.

In the first instance, the severely injured patient who is unconscious for a prolonged period and does not even remember the accident makes a prompt and complete recovery, while the patient who has had a narrow escape shows all the manifestations of the stress reaction produced by the shock of watching the oncoming catastrophe with a sense of complete helplessness.

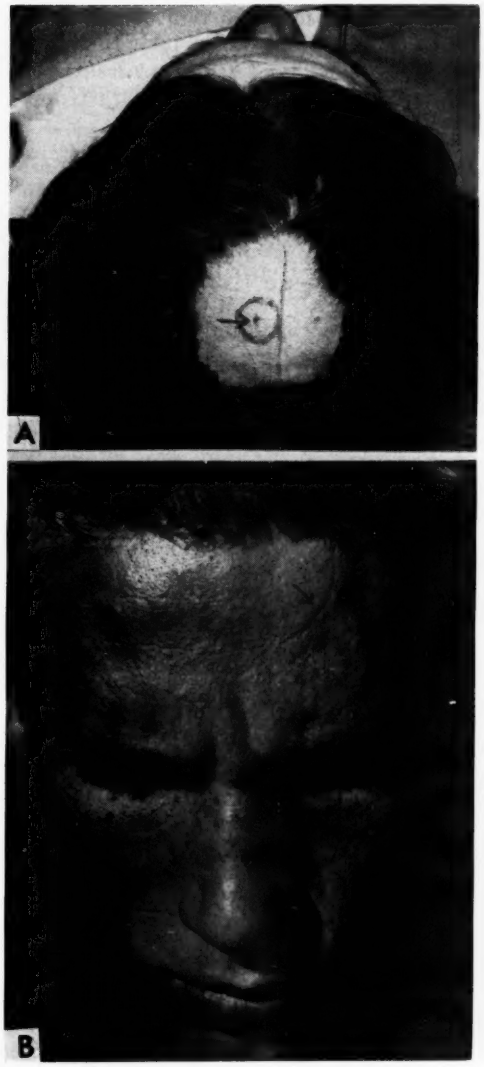

Fig. 4.—*A*, minute scar following local scalp contusion that produced attacks of left hemicrania, with pain behind left eye. *B*, healed scar involving twigs of left supraorbital nerve. Patient has periodic attacks of migraine-like headache.

SUMMARY

The author discusses accidental injuries to the head, together with the post-concussion syndrome. He points out that in the

United States the death rate from accidental injuries, emphatically including those sustained in motor accidents, greatly exceeds the death rate during a catastrophic war.

Craniocerebral injuries should be referred to the neurosurgeon. Extensive and brilliant advances have been made in their treatment, and the patient should not be denied the full benefit of these. Exhaustive and highly complicated neurologic knowledge and outstanding neurosurgical skill are required for proper management of these traumatic conditions.

SUMARIO

O A. discute as lesões acidentais da cabeça em conjunto com a sindrome pósconcussão. Estabelece que, nos EE.UU. a mortalidade por lesões acidentais inclue principalmente as decorrentes de acidentes com veículos motorizados as quais excedem, grandemente, os índices de morte durante a guerra.

Diz que as lesões cranio-cerebrais devem ser enviadas ao neurocirurgião. Refere que amplos e brilhantes progressos tem sido conseguidos neste sectorde tratamento do qual não deve ser privado o paciente. Conhecimentos neurológicos, exaustivos e complexos assim como grande habilidade neuro-cirúrgica são necessários.

RESUMEN

El autor discute los traumatismos accidentales de la cabeza junto con el síndrome de postconcusión. Él señala que en los Estados Unidos el índice de mortalidad por traumatismos accidentales, incluyendo aquellos ocurridos en accidentes motorizados, excede grandemente al índice de mortalidad durante una querra catastrófica.

Los traumatismos craneocerebrales debían referirse al neurocirujano. Progresos extensos y brillantes se han hecho en su tratamiento, cuyos totales beneficios no deben negársele al paciente.

Se requieren un agotador y altamente complicado conocimiento neurológico y una sobresaliente habilidad neuroquirúrgica.

RIASSUNTO

L'autore considera le lesioni accidentali del capo e la sindrome post-commozionale. Mette in rilievo il fatto che negli Stati Uniti le cifre di mortalità dovute a lesioni accidentali, e sopratutto a incidenti di automobile, sono di gran lunga superiori a quelle che si riscontrano durante le guerre più cruente.

Le lesioni cranio-cerebrali devono essere curate da un neurochirurgo. Si sono fatti incredibili progressi in questo campo e i pazienti hanno il diritto di giovarsene. E' necessaria una completa conoscenza dei problemi neurologici e una perfetta tecnica neurochirurgica.

ZUSAMMENFASSUNG

Der Verfasser erörtert die Unfallsverletzungen des Kopfes gemeinsam mit dem Syndrom der Gehirnerschütterung. Er hebt hervor, dass in den Vereinigten Staaten die durch Unfallsverletzungen hervorgerufene Sterblichkeit, und dazu gehören ganz besonders die Folgen von Automobilunfällen, bei weitem die aus einem katastrophalen Kriege resultierende Mortalitätsquote überschreitet.

Die Behandlung von Verletzungen des Kopfes und des Gehirns sollte dem Nervenchirurgen überlassen werden. Diese Spezialität hat umfangreiche und glänzende Fortschritte aufzuweisen, deren Segnungen dem Kranken voll nutzbar gemacht werden sollten. In solchen Fällen ist eine erschöpfende Kenntnis auf dem komplizierten Gebiet der Neurologie und eine ungewöhnliche neurochirurgische Geschicklichkeit erforderlich.

RÉSUMÉ

L'auteur discute les lésions accidentelles du cerveau et le syndrome post-commotionnel. Il signale qu'aux Etats-Unis le taux de mortalité de ces cas (y compris les accidents de voiture) dépasse largement le taux de mortalité produit par une guerre catastrophique.

Les lésions cranio-cérébrales doivent être adressées au neurochirurgien. De très grands progrès ont été réalisés et les malades devraient pouvoir en bénéficier. Ces cas exigent des connaissances approfondies dans le domaine si compliqué de la neurologie, ainsi qu'une grande habileté en neurochirurgie.

REFERENCES

1. Seletz, E.: Recent Trends in Management of Craniocerebral Injuries: A Plea for Prevention of Deaths from Reversible Injuries to the Brain, J.A.M.A. 158:535-538, 1955. Interval Intracranial Hemorrhage: Its Diagnosis and Management: Analysis of 25 Cases, Arch. Surg. 45:177-182, 1942.

2. Seletz, E.: Craniocerebral Injuries, Calif. Med. 84:292-294, 1956.

3. Gay, J. R., and Abbott, K. H.: Common Whiplash Injuries of the Neck, J.A.M.A. 152: 1698, 1953.

4. Raney, A. A.: Raney. R B., and Hunter, C. R.: Chronic Posttraumatic Headache and the Syndrome of Cervical Disc Lesion Following Head Trauma, J. Neurosurg. 6:458-465, 1949.

5. Robertson, R. C. L., and Peacher, W. G.: Management of Late Head Injuries, Am. Surg. 124:40-45, 1946.

6. Reichert, F. L.: Atypical Neuralgias of the Head, Headaches, So-Called Migraine and Complications of Whiplash Injuries and Other Cervical Trauma, Am. J. Surg. 89:1203-1211, 1955.

7. Jackson, R.: The Cervical Syndrome as a Cause of Migraine, J. A. M. Women's A. 2:529-534, 1947. Pentecost, P. S., and Adriani, J.: The Use of Cervical Plexus Block in the Diagnosis and Management of Atypical Cephalalgia of Cervical Origin, Anesthesiology 16:726-732, 1955. Reichert.[6]

8. Skillern, P. G.: Great Occipital-Trigeminus Syndrome as Revealed by Induction of Block, Arch. Neurol. & Psychiat. 72:335-340, 1954.

9. Weyburn-Mason, R.: The Nature of Trigeminal Neuralgia: Treatment by Alcohol Block or Section of the Great Auricular Nerve, Brit. M. J. 2:119, 1953.

10. Watts, J. W.; Wiley, W. B., and Groh, R. H.: The Relation of Contusion of the Scalp to Posttraumatic Headache and Dizziness, Tr. Publ. Assoc. for Nervous and Mental Dis. 24:562-577, 1945.

11. Chambers, W. R.: Posterior Rhizotomy of the Second and Third Cervical Nerves for Occipital Pain, J.A.M.A. 155:431-432, 1954.

12. Selye, H : The Physiology and Pathology of Exposure to Stress: A Treatise Based on the Concepts of the General Adaptation Syndrome, and the Diseases of Adaptation. Montreal, Canada: ACTA, Inc., 1950.

ADDITIONAL SOURCE

Mayfield, F. H.: Neurosurgical Aspects of Cervical Trauma. Clinical Neurosurgery. The Williams & Wilkins Company, 1955, vol. 2, pp. 983-999.

Science and art belong to the whole world, and before them vanish the barriers of nationality.

—*Goethe*

Healing is a matter of time, but it is sometimes also a matter of opportunity.

—*Hippocrates*

Tumors of the Brain

A Report on Two Hundred and Eighty-Eight Autopsies

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A REVIEW of operative deaths over a period of more than twenty-five years in any field of surgery is interesting, but a review of operative deaths in a highly specialized field, such as neurologic surgery, over the same period should be most enlightening, particularly in the face of the rapid progress of neurologic surgery in the past quarter century. Advances in any special field of medicine are enhanced far more by studying one's failures than one's successes, and the value of the autopsy cannot be too forcefully stressed. This report of autopsy observations includes data on deaths occurring in the operating room, to and including autopsies performed on patients as long as seventeen years after operation.

In spite of the physical aids now available for diagnosis and localization of intracranial neoplasms, it is still extremely important to obtain a careful history. Complete neurologic, ophthalmoscopic and roentgenographic examinations should be carried out before selected laboratory and special diagnostic examinations are utilized. Only by a carefully elicited history, and a meticulous general examination can one distinguish between co-existing diseases and the early symptoms of increased intracranial pressure, which may be associated with an expanding intracranial lesion, regardless of its location. Contrariwise, it must be remembered that many tumors—for example, those situated in the sella turcica, the chiasmal region and the cerebellopontine angle — may and frequently do give rise to localized symptoms before symptoms of increased intracranial pressure are manifested.

It is evident, therefore, that the symptoms of brain tumor vary according to the origin, site, rate of growth, size and pathologic features of the neoplasm. Most tumors of the intracranial cavity produce a chain of symptoms peculiar to their own life cycle. The necessity of a carefully elicited history and a complete neurologic examination is obvious. Most tumors in adults occur above the tentorium. The pronounced exception is perineural fibroblastoma of the eighth nerve. In children, most brain tumors occur in the cerebellum. The outstanding exceptions are Rathke's pouch cysts and craniopharyngioma.

The special diagnostic examinations and laboratory tests will be enumerated briefly in this presentation, with special emphasis on one procedure that has been most helpful in the treatment of malignant tumors of the brain, particularly the metastatic type.

Special diagnostic aids available and of assistance are here listed:

1. *Roentgenographic Studies of the Skull.*—These reveal convolutional markings in the calvarium, if present; destruction of the clinoid processes; ballooning of the sella turcica; erosion of the bone, e.g., the petrous bone; calcium deposits in a neoplasm or a vascular lesion; abnormal separation of sutures, and the shift of a calcified pineal gland.

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2. *Examinations of the Visual Field.*—These enable the examiner to detect defects in the field.

3. *Spinal Puncture.*—Spinal puncture is valuable for the determination of cell counts, the question of organisms, the Kahn test, and Lange colloidal gold test when indicated. An increase in protein is likely to be present. Spinal puncture should be discouraged in the presence of choked discs, since herniation of the brain through the tentorial notch or the foramen magnum may result in death.

4. *Pneumoencephalographic and Pneumoventriculographic Studies.* — Displacement, deformity, distortion or dilatation of the ventricles or the subarachnoid spaces can be detected by these means, which helps one to recognize the presence of an expanding lesion, hydrocephalus or cortical atrophy.

5. *Electroencephalographic Studies.*—Disturbance of the normal brain waves by a neoplasm or the presence of focal abnormalities, especially a delta focus, may be detected in the electroencephalogram.

6. *Angiographic and Arteriographic Studies.*—By these means one can outline a neoplasm. They are extremely useful in distinguishing lesions within and about the brain, especially lesions of cerebral vessels.

7. *Dye Studies in Combination with the Isotopes.* — As a diagnostic procedure, isotopes in conjunction with dye injected intravenously have a tendency to concentrate in an intracranial neoplasm (cysts excepted), making it possible to detect and localize a brain tumor by use of the Geiger counter.

Circumscribed benign and encapsulated tumors of the intracranial cavity are relatively easy to remove. Gliomas are the invasive types in the brain and should be regarded as malignant. Of this group, the medulloblastoma presents the most difficult problem. Glioblastoma multiforme may come on with precipitous suddenness and seems to originate most commonly in the white matter. Medulloblastoma and glioblastoma metastasize. In my own experience the only tumor of the brain that has shown definite evidence of metastasis is the medulloblastoma; several years ago, however, while in Vienna, I saw 2 patients with glioblastomas that showed evidence of metastasis.

Another group of malignant tumors of the brain is composed of the metastatic growths. Recurrent glioma of the brain, glioblastoma or spongioblastoma seldom metastasizes. The method of handling the latter group of neoplasms depends to a great extent on their location. Block dissection with total removal is the minimum operation to be considered. Lobectomy and, in some instances, total removal of the cerebral hemisphere is indicated and has proved effective.

For the glial group of tumors, medulloblastoma excepted, irradiation has proved disappointing, and in some instances the clinical progress would suggest that it accelerated the growth of the neoplasm. Irradiation after block dissection when recurrence has become evident has practically no effect on the lesion, not even in the relief of pain. I no longer advise or suggest irradiation therapy for the glioma group—medulloblastomas excepted—and I note that my results compare favorably with those of irradiation for the glioma type of tumor.

The various growths encountered, which include dermoid tumor, teratoma epidermoid tumor (cholesteatomas), chordoma and craniopharyngioma, are usually congenital. Meningioma, neuroma, angioma and hemangioblastoma are usually of mesodermal origin.

The pituitary tumors are usually mixed, but are distinguished as the chromophobe and the chromophil type.

Miscellaneous groups include the aneurysms, tuberculomas, gummas and parasitic formations.

The metastatic type of brain tumor usually metastasizes from carcinoma. The most common sources are the bronchi, the breast, the thyroid and the gastrointestinal tract. Sarcoma and, occasionally, melanoblastoma, hypernephroma and retinal tumor are not infrequently encountered.

Medulloblastoma, in my experience, occurs far more frequently in children than in adults, and certainly far more frequently in the posterior fossa. This is the one tumor originating in the intracranial cavity that has shown signs of metastasis. Recently the question has been raised whether some so-called medulloblastomas are actually neuroblastomas. Controversy over therapy still persists, unfortunately, and in some sections irradiation is employed, even without biopsy, for patients with lesions in the posterior fossa. Although in many instances irradiation is most beneficial, it is not infrequent to encounter intracranial neoplastic conditions other than medulloblastoma, such as astrocytomas and perineural fibroma, that do not respond to this form of treatment.

My handling of medulloblastoma over a period of years has been radical excision of the tumor (in spite of the additional risk), followed by irradiation of the entire cerebrospinal system. The dosage is the maximum skin tolerance dose: 200 kilovolts, 15 milliamperes, 50 cm. focal skin distance, with added filter, 1 mm. of copper and 1 mm. of aluminum; primarily one port 10 by 10 cm. (posterior fossa); 2 lateral ports 7 by 12 cm.; 2,500 R over each; tumor dose 4,000 R plus; vertebral column 3 to 4 fields; lateral shielding 200 R to each. Caution: Fractionation of blood, the leukocyte count, etc., must be watched. Transfusion may be indicated.

In postoperative recurrences of medulloblastoma, irradiation therapy frequently gives prompt relief of pain and improvement of general physical condition. Metastases of this type spread by seeding and actual metastasis.

Since this procedure has been followed I have been able to report a series of cases in which the patients, at the time of writing, have survived from nine to seventeen years without symptoms.

For the glial group of tumors (i.e., the recurrent type) block dissection, lobectomy and hemispherectomy have proved effective in a large percentage of cases. The survival period in this group has ranged from two to eleven and one-half years, symptom free. In some cases of recurrent tumor in which reoperation was done the results were most disappointing. The rest, treated with irradiation therapy, proved most discouraging. I am consequently convinced that the only method of treatment of recurrent medulloblastoma is radical removal with intensive postoperative irradiation. This seems to be the most rational method of handling this type of lesion.

Metastatic lesions to the brain are observed most frequently after thoracic operations for bronchogenic carcinoma. Metastases from the gastrointestinal tract and the kidneys occur. Because the primary site of the lesions has been definitely determined, it has been the custom in many neurosurgical services to consider any intracranial expanding lesion a metastasis if it occurs in conjunction with malignant change in some other part of the body. This has not been my experience; I have known meningioma, astrocytoma and oligodendroglioma to occur in this type of patient, independent of the initial carcinomatous lesion. In several instances I have observed lesions in the intracranial cavity arising from the membranes of the vault in conjunction with metastatic tumor in the intracranial cavity. For more than fifteen years I have performed pneu-

TABLE 1.—*Causes of Death in Two Hundred and Eighty-Eight Cases*

Acute edema of the lungs	145	50%+
Terminal bronchopneumonia	56	16%
Hyperpyrexia	21	7%+
Aspiration pneumonia	14	5%
Edema of the pons	9	3%+
Edema of the brain (general)	8	2%+
Postoperative hemorrhage	6	2%
Surgical shock	6	2%
Myocardial collapse, etc. (tuberculosis, diffuse tumors of base)	23	7%

moventriculographic studies to determine whether or not I was dealing with a single metastatic lesion or with multiple ones. If the metastasis is single, radical removal is always advised. The survival period in this group ranges from nine months to three and one-half years. The diagnostic procedure that has proved especially advantageous in recent years is the use of fluorescein dyes in conjunction with isotopes, injected intravenously, and localization of the lesion with a Geiger counter. If the Geiger counter record suggests multiple lesions, I do not attempt to remove them but resort instead to simple subtemporal decompression. If, on the other hand, a single lesion is demonstrated, it is immediately removed.

The number of operative deaths in the past twenty-five years has been constantly reduced, not only because of improvement in armamentarium, early diagnosis and postoperative care but because of the introduction of sulfa drugs, antibiotics and the maintenance of fluid and electrolytic balance.

Table 1, which records 288 deaths with autopsy observations, shows that the most serious complicating problem is still any-

TABLE 2.—*Types of Tumor*

	1927 to 1935	*1936 to 1940*	*1941 to 1945*	*1946 to 1952*
Glioblastoma multiforme	26	26	40	6
Medulloblastoma	16	10	8	0
Astrocytoma	13	6	4	2
Perineural fibroma	7	4	6	2
Meningioma	5	4	8 (4 parasagittal)	2
Adenoma of pituitary	4	1	6 (2 malignant)	1
Intraventricular ependymoma	3	2	2	4
Suprasellar	2	5	3 (2 malignant)	1
Metastatic	0	2	2	4
Pontine	4	1	3	3
Ependymoma of 3d ventricle	2	3	6	1
Hemangioblastoma	1	1	1	2
Hemangioma	3 (1 in 3d ventricle)	0	0	0
Giant cell sarcoma	1	1	1 (bilateral)	0
Cholesteatoma of 4th ventricle	1	0	0	0
Carcinoma of nasopharynx with extension into brain	2	0	0	0
All others	7	0	0	0

TABLE 3.—*Analysis of Deaths from Tumors of the Brain*

Glioblastoma multiforme	
(13 bilateral, extending through corpus callosum); 8 hemispherectomies	98
Cause of death:	
Acute edema of lungs	59
Bilateral bronchopneumonia	23
Edema of brain	7
Renal suppression with myocarditis	2
Hyperpyrexia	2
Postoperative hemorrhage unrecognized	1
Active tuberculosis of lungs with edema	1
Surgical shock	1
Aspiration pneumonia	2
1 hemispherectomy; survival period 11½ years	
Medulloblastoma (complete radical removal)	34
Cause of death:	
Acute edema of lungs	21
Hyperpyrexia	7
Myocardial collapse	1
Terminal bronchopneumonia	4
Aspiration pneumonia	1
Astrocytoma	25
Cause of death:	
Acute edema of lungs	8
Aspiration pneumonia	4
Terminal bronchopneumonia	7
Postoperative hemorrhage	1
Surgical shock	2
Pulmonary tuberculosis with edema	1
Massive subcortical hemorrhage (on table)	1
Perineural fibroblastoma (8th nerve)	19
Cause of death:	
Acute edema of brain and lungs	5
Terminal bronchopneumonia	4
Edema of pons	5
Acute edema of lungs	2
Acute edema of brain	1
Myocardial collapse	1
Aspiration pneumonia	1
Meningioma	19
Cause of death:	
Acute edema of lungs	15
Postoperative hemorrhage	2
Bronchopneumonia (terminal)	1
Aspiration pneumonia	1
Neuroepithelioma	1
Cause of death:	
Acute edema of lungs	1
Adenoma of pituitary	14
Cause of death:	
Terminal bronchopneumonia	3
Aspiration pneumonia	2
Acute edema of lungs	7
Postoperative hemorrhage	1
Surgical shock	1
Malignant tumor of pituitary	3
Cause of death:	
Postoperative hemorrhage	1
Hyperpyrexia	2
Ependymoma, intraventricular	11
Cause of death:	
Hyperpyrexia	3
Acute edema of lungs	4
Bronchopneumonia	3
Bronchopneumonia with metastasis to lungs	1
Suprasellar lesions	
(Cysts and craniopharyngiomas; 1 dermoid, 1 malignant)	11
Cause of death:	
Hyperpyrexia	4
Acute edema of lungs	6
Aspiration pneumonia	1
Metastatic	8
Cause of death:	
Bronchopneumonia (1 multiple metastasis)	3
Bronchogenic carcinoma of lungs with edema	2
Diffuse metastases to lungs and brain	1
Squamous carcinoma of middle fossa to clivus involving cranial nerves 3, 4, 5, 6, 7, 8, 9, 10 and 11	1
Acute edema of lungs	1
Pontine	11
Cause of death:	
Hyperpyrexia	4
Bronchopneumonia	2
Acute edema of lungs	1
Acute edema of pons	4
Ependymoma of 3d ventricle	12
Cause of death:	
Acute edema of lungs	5
Bronchopneumonia—bilateral terminal	4
Surgical shock	2
Myocardial collapse	1
Hemangioblastoma	8
Cause of death:	
Acute edema of lungs	6
Aspiration pneumonia with gangrene of lungs	2
Hemangioma (intraventricular)	3
Cause of death:	
Acute edema of lungs	2
Hypernephroma with metastases to lung	1
Cholesteatoma (4th ventricle)	1
Cause of death:	
Acute edema of lungs	1
Giant cell sarcoma (1 bilateral)	3
Cause of death:	
Aspiration pneumonia	1
Bronchopneumonia	1
Entire floor of skull extending into clivus with acute edema of brain and lungs	1
Carcinoma of nasopharynx into brain	2
Cause of death:	
Bronchopneumonia with metastasis	2
Tuberculoma	2
Cause of death:	
Tuberculous meningitis	2
Pinealoma	4
Cause of death:	
Medullary collapse	1
Acute edema of lungs	3
Spongioblastoma apolare	1
Cause of death:	
Acute edema of lungs	1
Thrombosis of anterior cerebral artery and intraventricular vessels	1
Cause of death:	
Bronchopneumonia	1

thing but solved. Approximately 50 per cent of all deaths after operation for brain tumor in this clinic were due to acute edema of the lungs. The treatment of this complication has shown practically no improvement until recently. Since the introduction of antibiotics and sulfa drugs the incidence of terminal pneumonia has been greatly reduced, and in the past eight years death due to terminal pneumonia has been practically nil. Aspiration pneumonia occurred most frequently during World War II, primarily because of inexperienced and inefficient personnel. Edema of the pons occurred primarily in pontine lesions when a heroic effort was made to remove them. The incidence of unrecognized postoperative hemorrhage, fortunately, is very low—2 per cent. Careful postoperative follow-up observations should eliminate this entirely. Under "surgical shock" are listed deaths that occurred on the operating table. Anesthesia had no influence.

It is quite evident from these statistics that, if adequate satisfactory treatment can be instituted to counteract acute edema of the lungs, the operative mortality rate would drop 50 per cent.

It is fair to assume, therefore, that fluid and electrolytic balance in the immediate postoperative period is of the utmost importance. For the past fifteen years potassium, sodium and chloride evaluations have been made preoperatively, and the proper balance becomes increasingly important as the age of the patient increases. Evidence shows that the immediate postoperative time is a period of disturbed renal function. During the operation, and for about twelve hours thereafter, intravenous injections should be limited mostly to the replacement of lost blood, plus a sufficient quantity of 5 per cent dextrose in water to cover insensible losses. Saline solution, unless the blood chloride level is low, should be dispensed with. The necessity of maintaining postoperative fluid and electrolytic balance cannot be too strongly emphasized. The total fluid intake for the first three or four days should seldom be more than 3,000 cc. in twenty-four hours. Dextrose in water should be relied upon. One hundred Gm. of dextrose is sufficient to prevent ketosis. Some authors recommend withholding salt solution until after the fifth postoperative day. Others recommend a simple electrolytic combination of sodium, potassium and chloride in a 10 per cent solution of dextrose in water, or a 10 per cent amino acid mixture.

Evaluating and maintaining the fluid and electrolytic balance postoperatively should be most helpful in reducing operative mortality and complications, particularly edema of the brain and lungs.

The incidence of death from glioblastoma multiforme (Table 2) increased from 1936 through 1945, during which period extreme radical attacks were carried out on this type of tumor. Many multiple lobectomies and hemispherectomies were done. Of the deaths, 8 followed hemispherectomy. Justification for this type of radical operation, in my opinion, can be substantiated in that the survival of patients hemispherectomized and lobectomized for glioblastoma has ranged from two to eleven and one-half years.

The incidence of death from medulloblastomas has gradually decreased, in spite of radical removal followed by heavy irradiation. The survival period has ranged from two years to seventeen years and four months, which in my opinion justifies the additional risk of the primary operation. For single metastatic tumors of the brain I definitely advise removal. The survival period here has been as long as three and one-half years.

Table 3 contains a more detailed account of the cause of death from the various types of lesion, and the natural conclusion, which I wish again to emphasize, is the

necessity for circumvention, prevention and adequate therapy of acute edema of the lungs. If the same progress could be made in the treatment of this complication as has been made with pneumonia, the operative mortality rate would be strikingly diminished.

CONCLUSION

It is evident from the information listed that the proper handling and treatment of complications attending tumors of the brain, since the recent marked advance in surgical acumen, must be devoted primarily to treatment of acute edema of the lungs. This can best be accomplished by establishing and maintaining the fluid and electrolytic balance. Water intoxication and an unrecognized depletion of sodium are effectively combated by administration of isotonic or concentrated solutions of sodium chloride. In spite of the discouraging results with pontine tumors, continued attack on this type of lesion should be encouraged.

CONCLUSIONS

Depuis les récents grands progrès de la chirurgie il ressort de toutes les observations que le traitement des complications accompagnant les tumeurs cérébrales, doit être dédié en premier lieu à l'oedème pulmonaire aigu. Le mieux est d'établir et de maintenir l'équilibre des liquides et l'équilibre électrolytique. Une intoxication hydrique et une déperdition de sodium sont efficacement combattues par l'administration d'un isotonique ou d'une solution concentrée de chlorure de sodium. Malgré les résultats décourageants obtenus jusqu'ici dans les cas de tumeur du pont de Varole nous devons nous attacher à poursuivre nos efforts dans ce domaine.

SCHLUSSFOLGERUNGEN

Aus den in der Arbeit dargelegten Erfahrungen geht hervor, dass seit die chirurgischen Kenntnisse erhebliche neue Fortschritte aufzuweisen haben, die Behandlung der Komplikationen von Hirntumoren sich in erster Linie dem akuten Lungenödem zu widmen hat. Dies geschieht am besten durch Herstellung und Erhaltung der Flüssigkeits- und Elektrolytenbilanz. Die Wasserintoxikation und eine unerkannte Natriumverarmung werden durch Verabreichung isotonischer oder konzentrierter Kochsalzlösungen wirksam gekämpft. Trotz der entmutigenden Ergebnisse der chirurgischen Behandlung von Brückentumoren sollte die Fortsetzung der Angriffe auf diese Art der Erkrankung nicht aufgegeben werden.

CONCLUSOES

Acentua que o planejamento a tratamento das complicações dos tumores cerebrais, considerando-se os recentes progressos da cirurgia, devem ser inicialmente dedicados ao tratamento do edema agudo dos pulmões. Esse objetivo pode ser melhor atingido pelo estabebecimento e manutenção do equilibrio hidro-eletrolítico.

CONCLUSION

Es evidente por nuestra información que el manejo y tratamiento de complicaciones de tumores cerebrales, desde el marcado avance reciente de el acumen quirúrgico, debe dirigirse primariamente a tratar el edema agudo del pulmon. Esto puede lograrse mejor estavlesiendo y manteniendo el balance fluido y electrolítico. La intoxicacion por agua una desconocida depleción de sodio son efectivamente convatidas por la administración de soluciones isotónicas o concentradas de cloruro de sodio. No obstanto los resultados desalentadores con los tumores pontinos, ataques continuados hacéa ese tipo de lesión deben recomendarse.

Orthopedic Surgery

Treatment of Fracture-Dislocation of the Shoulder

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MODERN methods of treatment for fracture-dislocation of the shoulder joint have not secured favorable results in an acceptable proportion of patients treated for this injury. The lesion is not often encountered, so that opportunities for standardization of available technics are inadequate. Neer[1] and his collaborators reported the incidence to be 1.1 per cent in a series of 1,796 cases of dislocations of the shoulder and fractures of the upper part of the humerus.

The methods of treatment in vogue today encompass a wide variety of procedures, ranging from simple sling immobilization without reduction of the deformity to replacement of the humeral head with a metallic or an acrylic prosthesis. Watson-Jones[2] described manual manipulation followed by immobilization for three weeks in a collar and cuff sling and axillary pad and warned against the use of abduction frames or skeletal traction. Michaels[3] reported 2 cases in which the condition was treated by excision of the head fragments and stated that he "cannot see any justification for attempting closed reduction." Key and Conwell[4] stated that they treat the fracture by traction, utilizing the Boehler traction apparatus, a fracture table or manual traction. The head is pushed upward by direct pressure and its position maintained by a plaster spica or a lateral traction frame. Steindler[5] advised open reduction and resection of the humeral head in a series of twelve unreduced cases. Campbell[6] performed open reduction and wiring of the bone fragments after reduction but favored a tendinoplastic procedure described by Jones.[7]

Neer, Brown and McLaughlin[1] reported 20 cases of fracture-dislocation in 1953 with successful closed reduction of 2 impacted lesions; open reduction in 1 case, removal of the humeral head in 8, arthrodesis in 1 and plastic operation upon the musculotendinous cuff or the acromion in 8. They concluded that the last-mentioned procedures did not improve the end results and that the best treatment available at that time (1953) was simple excision of the head. They suggested the use of a metallic replacement prosthesis, and in 1955 Neer[8] reported 12 cases in which a vitallium shoulder prosthesis had been inserted, with good results in 11.

MacAusland,[9] Gilfillan,[10] Judet,[11] Krueger,[12] Fellander[13] and others have reported the use of acrylic and vitallium prostheses, with good restoration of function.

Technic for Closed Reduction.—The principles of the method have been described by several authors, but without conviction as to its efficiency.[14] The basic

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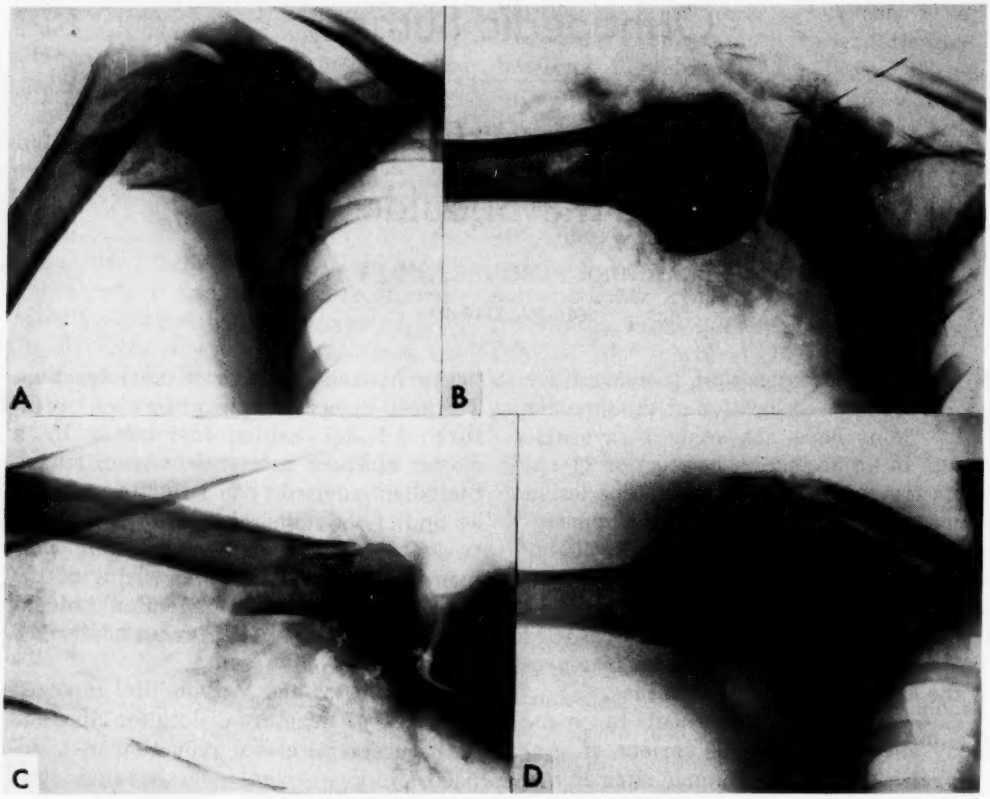


Fig. 1.—*A*, roentgenogram illustrating the type of injury under discussion. M. G., an engineer and shipbuilder, aged 32, fell off a horse on Feb. 8, 1942, injuring his left shoulder. The film shows a severe fracture-dislocation of the extracapsular type, with considerable comminution of the proximal fragment. The head was dislocated anteriorly in the infracoracoid position, and the shaft was pulled upward to about an inch and a half of shortening. *B*, film taken shortly after reduction with cast in position, showing that the dislocation has been reduced. The fracture fragments are in good anatomic alignment, and the shoulder is held in 80 degrees of abduction in fixed traction by the technic here described. Note increased joint space and capsular stretch. *C*, film taken in the vertical plane, showing good contact between the fracture fragments, with the head of the humerus in proper contact with the glenoid. Soft tissue structures under tension act as an internal splint. *D*, film taken eight weeks after the operation, showing fracture lines obliterated by callus formation, with minimal angulation at the fracture site. Circulation of the humeral head is intact. Further roentgen studies are not available, but when last examined, nine years after the injury, the patient had regained almost complete function in the shoulder joint, without deformity or muscle atrophy. He was entirely without pain and was able to make free use of the left arm in his work as a shipbuilder.

difficulties encountered can be described as twofold: failure to reduce the fracture-dislocation and/or failure to maintain reduction. It is my contention that, if adequate reduction is obtained without subsequent displacement, the incidence of aseptic necrosis and poor end results will be considerably diminished (Fig. 1, *A* to *D*). In order to achieve this end, one must apply the maximum degree of traction that the upper extremity can tolerate. This is accomplished by positioning the patient on a fracture table that permits traction on the upper extremity — preferably the Albee-Comper table (Fig. 2*A*). The shoulder is gently abducted to 90 degrees

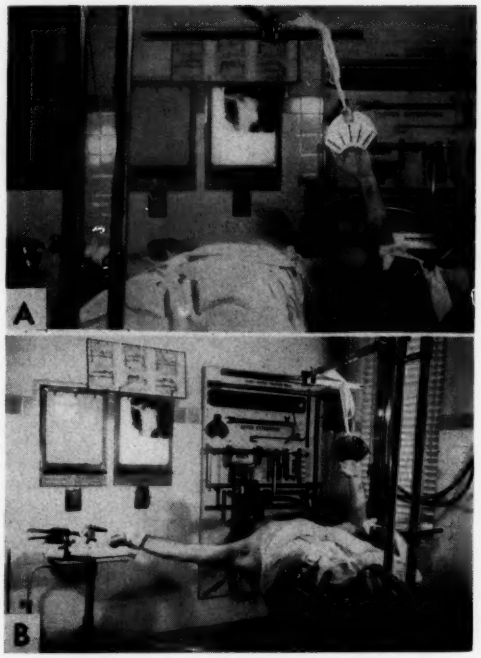


Fig. 2.—*A*, technic. Patient on Albee fracture table. Injured arm secured to traction bar by means of muslin bandage loops from olecranon bone pin to footpiece in upper extremity position. Shoulder abducted to 90 degrees and elbow flexed to 80 degrees, with hand suspended from overhead crossbar. Note accessibility of lesion to roentgen study. See text for details of manipulation. *B*, efficient countertraction to the opposite arm, stabilizing the injured shoulder joint and permitting reduction of the fracture-dislocation. Opposite shoulder in full abduction—tied to traction bar with elbow extended. Bar must be tied to wall fixture to maintain fixed position when extreme traction is applied during reduction. See text.

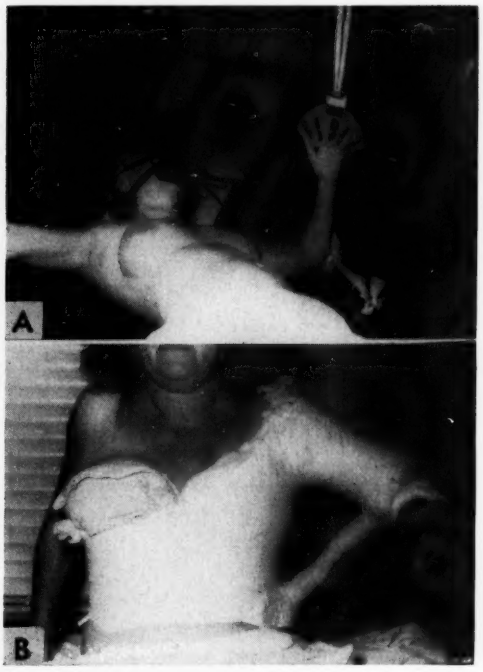


Fig. 3.—*A*, anterior view showing traction and countertraction. Overcorrection of shortening at fracture site removes bony obstacles to reduction of the humeral head. *B*, patient ambulatory in spica cast twenty-four hours after reduction. Fixed traction maintained between olecranon bone pin and thoracic wall, which must be heavily padded. See text for management of convalescence.

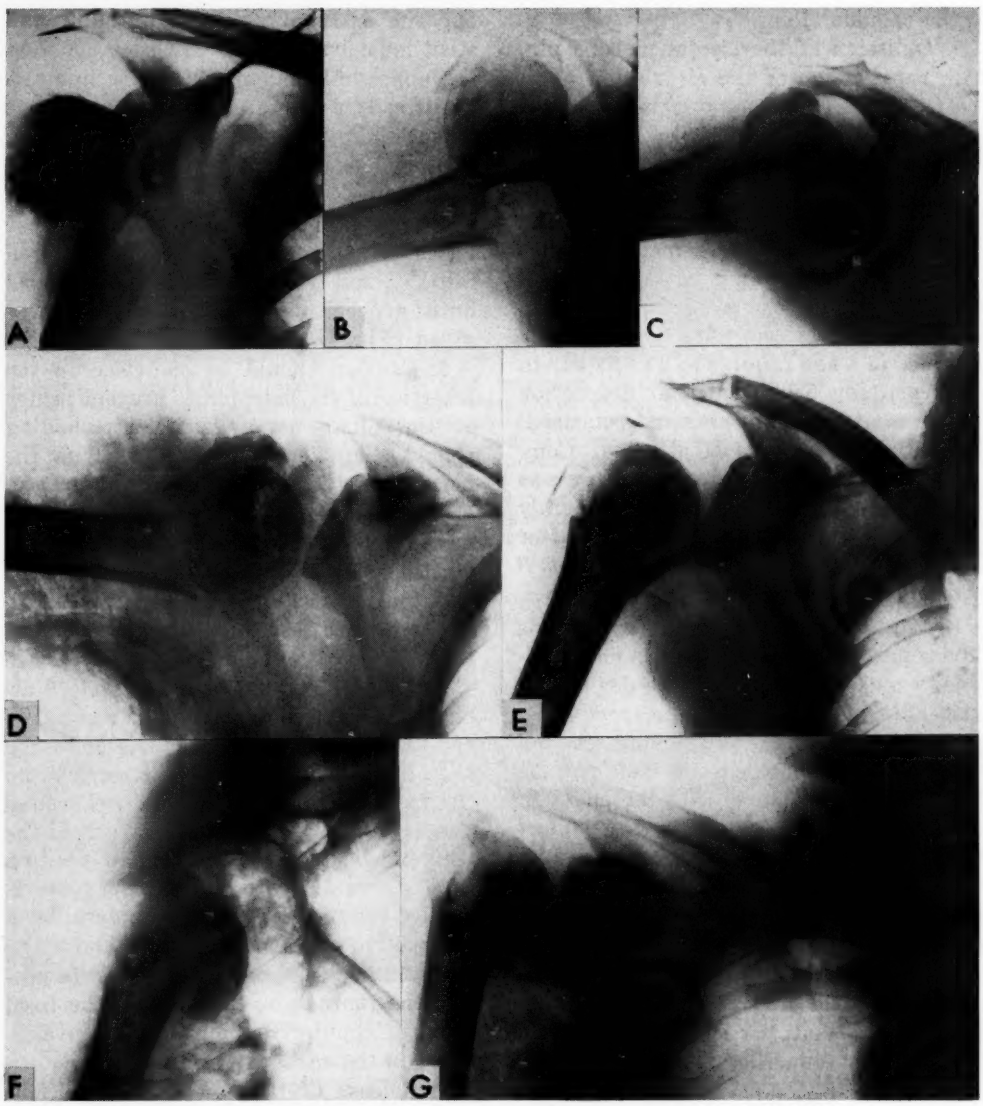
and the fingers suspended to an overhead bar with the elbow in not more than 80 degrees of flexion. A 5/32 inch Steinman pin is drilled through the olecranon and connected to the traction bar by means of a separate loop of heavy muslin bandage over each protruding end of the pin. Both loops must be kept close to the point of emergence of the pin through the skin and crisscrossed or tied together close to the elbow before being tied to the traction bar. Failure to do this will result in bending of

Fig. 4.—*A*, patient J. B., aged 61, a golf caddy. End result eight months after treatment for fracture-dislocation of left shoulder by fixed traction method. Complete rehabilitation with asymptomatic shoulder. *B*, minimal muscle atrophy and restriction of internal rotation.

Fig. 5 (*opposite*)—*A*, patient R. M., aged 40, male. Left shoulder injured by diving off a high board with arm abducted when he struck the water. Roentgenogram shows a comminuted fracture through the surgical neck, complete rotation of the humeral head and anterior dislocation of the shoulder joint. *B*, film taken in the operating room with left humerus in fixed traction. Brachial anesthesia was used but did not secure sufficient muscular relaxation for reduction of the head. *C*, film taken in operating room, with limit of traction applied, after further manipulation with patient under general anesthesia. Note that adequate room has been provided for return of humeral head to shoulder joint. *D*, traction partially released to permit contact between proximal and distal fragment and cast applied. Joint space is still increased, however, and capsule is under maximum stretch. Stretching of capsule that is obtained in the procedure appears to facilitate later return of function. *E*, film taken sixteen days after injury. Patient returned to his home three days after injury; four days later his physician observed partial palsy of the ulnar nerve. He considered this due to injury by the Steinman pin through the olecranon and accordingly removed the pin and the spica cast and applied a hanging cast. Film *E*, taken sixteen days after the injury, shows beginning displacement of fracture after removal of spica cast. *F*, film taken five weeks after reduction with hanging cast treatment. Note overriding of fragments and subluxation of shoulder joint. *G*, appearance two years later. I have been advised that patient has a serviceable shoulder but shows residual signs of partial palsy of the ulnar nerve. In this connection, it might be noted that injury to the ulnar nerve was not evident three days after the injury, so that it is reasonable to assume that the nerve was injured by insufficient padding in the plaster cast at the elbow. When the Steinman pin is inserted through the medial side of the olecranon, there is little likelihood of direct nerve damage.

the pin and slipping of the loops off the pin when traction is applied. The telescoping traction bar and gear are adjusted to allow for maximum uptake later, and the shoulder is stabilized by a few turns of the lever.

The most potent factor in securing reduction is provision for proper countertraction. To accomplish this, the opposite extremity is secured to the other traction bar with the shoulder abducted to 90 degrees and the elbow fully extended (Fig. 2*B*). A muslin bandage engages the wrist joint in a clove hitch knot and the two ends are secured to the footpiece, after which sufficient traction to overcome the sag of the extremity is applied. The degree of traction is gradually increased on the injured side until the soft tissue structures are taut. When extreme traction is attained the Steinman pin will bend, but the surgeon may continue turning the lever cautiously until the limit of tolerance is reached. Attention is then directed to the head of the humerus. Direct manual thrust is applied by the closed fist or fingers of one hand, while the surgeon's other hand grasps the upper humeral shaft and gently oscillates the arm. In some cases reduction will be heralded by a sudden loud snap. If this is not forthcoming, the position of the head may be ascertained by palpation, and, if it is deemed to be satisfactory, roentgen studies in two planes are obtained by means of a portable roentgen machine in the operating room. Further manipulation may be necessary to improve the degree of reduction or rotation of the head, and its direction will be guided by the roentgen appearance. The upper and lower fragments are firmly grasped, one in each hand, and forcefully angulated upward, then outward; this usually suffices to effect anatomic alignment. If additional roentgenograms show distraction of the fracture, traction may be gently decreased to permit good contact. A thick felt pad is applied to the thoracic wall in the axillary line, and a well-fitting shoulder spica is molded in position, incorporating the bone pin at the elbow (Fig. 3, *A* and *B*). The patient is returned to bed and may be ambulatory on the following day. Postreduction roentgenograms are taken and rechecked once a week for three weeks. The upper shell of the arm cast and the Steinman pin are removed in the fifth week, and active exercises are begun in the sixth. The cast may be discarded several days later, although the use of a sling and a large axillary pad may be necessary before the transition to neutral position is reached.



Intensive physiotherapy is administered until maximum function is reestablished. The average duration of treatment is twelve weeks (Fig. 4, *A* and *B*).

In a series of 11 cases, good results were obtained in 5 and unsatisfactory results in 6. The causes of failure were:

1. Injury to the ulnar nerve (Fig. 5).

2. Delayed open reduction, with calcification of the capsule (Fig. 6, *A* and *B*).

3. Delayed open reduction with postoperative infection, necessitating removal of the humeral head.

4. Delayed closed reduction, with an attempt to reduce the head by using a Steinman pin as a lever to "pry" it back

to the shoulder joint.

5. Omission of the olecranon bone pin, with constriction of the circulation when the elbow joint did not remain in a fixed position in the cast.

6. The use of manipulation and a hanging cast in a borderline case, with complete displacement two weeks later. The patient returned to his home in another city for further treatment.

There were 6 cases of complete extracapsular dislocation. Good results were obtained in 3 and failures in 3 as listed. In the remaining 5 intracapsular dislocation was present, with anterior and rotational dislocation as high as 80 degrees. Comminution of the humeral head fracture was usually seen. End results were consistently better in the second half of the series, after the technic was standardized (Fig. 7, *A*, *B* and *C*).

Precautions.—1. Immediate reduction is advisable. If a fracture table is not available, a makeshift table can be devised by suspending the patient on a narrow board between two tables and applying traction with a block and tackle to the bone pin, the wrist being held above, with the elbow in flexed position, by the assistant. Countertraction to the opposite arm is secured by a loop of bandage fastened to an immovable fixture in the operating room, such as a radiator, window handle or water pipe.

2. In positioning the patient on a fracture table, a narrow spinal bar is fitted to the table so that the spica cast may be applied after reduction.

3. The fracture table selected must have facilities for traction on the upper extremity. The Albee-Compere table is provided with an adjustable compression strut interposed between the traction bar and the supporting framework of the table to prevent adduction of the shoulder as traction is increased. The manufacturer fails, however, to provide a second strut for the opposite extremity, so that an additional strut must be ordered. If this is lacking, the opposite traction bar can be immobilized by tying it to a rigid fixture in the operating room as aforedescribed (Fig. 2*B*).

4. General anesthesia is essential for proper muscular relaxation. In 1 case brachial plexus block was administered initially, but reduction was not possible until general inhalation anesthesia was given (Fig. 5*B*).

5. Caution should be exercised in the insertion of the bone pin to prevent injury of the ulnar nerve; sufficient padding should be applied to the skin overlying the nerve.

6. Manual traction or traction with adhesive tape cannot adequately replace pin traction. In 2 early cases in which this was tried the elbow joint slid upward in the cast, with resultant pain and constriction of circulation.

7. Countertraction is ineffectual if attempted by fixing the chest against a curved bar attached to the table or by the aid of an assistant who pulls away from the operating surgeon with a towel around the chest. These measures do not hold the scapula and glenoid in the fixed position that is essential before sufficient space is created for reposition of the humeral head by traction on the injured shoulder.

8. A thick felt pad must be used to protect the thoracic wall, which is the fixed point of countertraction during convalescence in the cast.

9. Release of traction before sufficient callus forms will result in redisplacement of the fragments (Fig. 5*F*). A minimum of five weeks of uninterrupted fixed traction is required.

COMMENT

The results heretofore obtained in treating fracture-dislocation of the shoulder

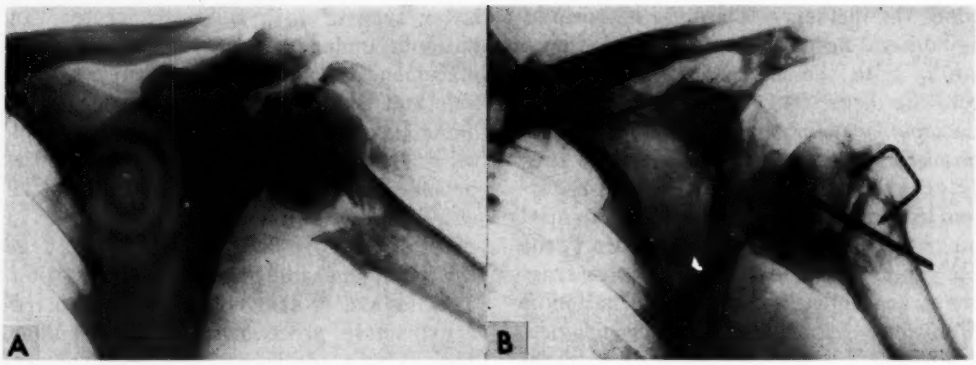


Fig. 6.—*A*, patient J. P., injured Sept. 15, 1952, in central Florida, when he swerved his car to avoid a wheel which had broken loose from a truck-trailer coming from the opposite direction. The car struck a pole and he sustained a fracture-dislocation of the left shoulder and a fracture of the femur. He was brought to Miami ten days later and, in view of the delay, I elected to do an open reduction. This case is shown to demonstrate the advantage of applying fixed traction during the course of operation. *B*, open reduction performed with upper extremity attached to traction bar by means of an olecranon pin. Minimal fixation devices were utilized to restore position of fracture at shoulder joint. Three and a half years later, calcification of the capsule is evident, as well as inferior subluxation. Abduction is limited at 80 degrees, with mild limitation of internal and external rotation. Patient works full time as a waiter in a local restaurant.

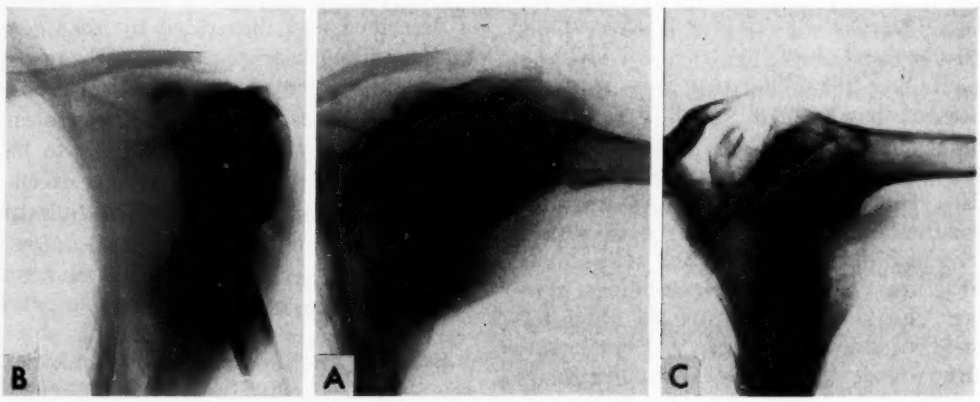


Fig. 7.—*B*, patient M. M., aged 51, injured June 21, 1953, in a motor accident, shows a comminuted fracture through surgical neck of humerus with anterior and rotational dislocation of the humeral head. Several fractural lines extend into humeral head but there is only minimal displacement of the greater tuberosity. *A*, film taken in operating room. Immediate reduction was done by fixed traction method. Head of humerus is derotated and in satisfactory alignment. *C*, end result three years later. Complete restoration of circulation through humeral head. No evidence of aseptic necrosis. Full range of painless motion regained.

have not been comparable to those obtained with other skeletal injuries. I attribute this to the difficulties encountered in the application of traction to the upper extremity, which are so considerable that the maximum pull available has not been employed. Although methods of obtaining fixed skeletal traction have been described, they fall short in not providing for countertraction that will not only make full reduction possible but permit the reduced position to be maintained during convalescence.

Adequate reduction and fixation should

reduce the incidence of aseptic necrosis of the humeral head by permitting maximum contact with the medullary blood supply from the distal fragment. The unreduced anatomic head of the humerus is almost completely deprived of arterial blood supply. Further, if the need for open reduction in many cases is obviated, potential sources of blood supply from soft tissue attachments to the proximal bone fragments are conserved. Open reduction is often complicated by extensive calcification of the shoulder capsule and ligaments (Fig. 6*B*). Increased efficiency of closed procedures will minimize the frequency of this occurrence.

Many surgeons resort to excision of the head of the humerus in the initial stages of treatment rather than subject the patient to a lengthy convalescence, terminated by degeneration of the humeral head. Partial resection of a major joint must be considered a drastic procedure and should be withheld until all other available methods have failed. This is especially applicable in the case of young adults or the middle-aged. Replacement of the excised head fragments with an artificial prosthesis offers interesting possibilities for rehabilitation; restoration of anatomic structures by physiologic healing, however, should be the goal toward which the surgeon strives. Badgley[15] commented: "Experience in the past thirty-five years or more in bone and joint surgery has convinced me of the inability of any foreign material to take the place of bone for any length of time."

Replacement of the humeral head by a prosthesis should be reserved for shoulders with advanced degenerative or destructive lesions.

The fixed traction method is useful in the handling of difficult fractures of the surgical neck of the humerus and fracture-separations of the proximal humeral epiphysis. In reporting 43 cases of the latter type of injury, Smith wrote: "In patients under fifteen with marked displacement, should we keep them comfortable and let nature correct the deformity or should we try to find a more satisfactory type of internal fixation?" Since the problem of obtaining reduction in such cases is similar to that encountered in cases of fracture-dislocation, I would urge the employment of fixed shoulder traction. The method is also helpful in certain reconstructive procedures of the shoulder, such as arthrodesis and bone graft replacement of the proximal portion of the humerus when this has been destroyed by neoplasm.

SUMMARY

A revised technic for the closed reduction of fracture-dislocation of the shoulder is described and illustrated by roentgen studies and photographs taken in the operating room. The method of maintaining the corrected position during the convalescent period is shown. Precautions to be taken by the surgeon for the proper execution of the procedure and the pitfalls to be avoided are outlined.

ZUSAMMENFASSUNG

Es wird eine verbesserte Technik der geschlossenen Reduktion von Verrenkungsbrüchen der Schulter beschrieben. Das Verfahren wird an Hand von im Operationssaal angefertigten Röntgenbildern und Photographien erläutert. Es wird gezeigt, auf welche Weise die erzielte Stellung des Gelenks in der Zeit der Rekonvaleszenz erhalten werden kann. Die vom Chirurgen zu beachtenden Vorsichtsmassnahmen bei richtiger Ausführung des Verfahrens und gewisse Tücken der Methode, denen man ausweichen muss, werden umrissen.

RÉSUMÉ

L'auteur décrit une technique revisée pour la réduction non sanglante de la fracture-dislocation de l'épaule, illustrée par des études radiographiques et photographiques. Il indique une méthode pour le maintien d'une position correcte durant la période de convalescence, et énumère les précautions à prendre par le chirurgien pour sa bonne exécution, ainsi que les pièges à éviter.

SUMARIO

Revisão da técnica para a redução não sangrante da fratura-luxação do ombro com estudos radiograficos e fotograficos atraves documentaçõ obtida na sala cirúrgica. Mostra a menira de manter a posição correta durante a convalescença. Cita as precauções a que deve atender o cirurgiões assim como fixa os percalços que devem ser evitados.

CONCLUSIONES

Se describe una técnica revisada para la reducción cerrada de las fracturas-lujaciones del hombro y se ilustran con estudios radiológicos y fotografías tomadas en la sala de operaciones. Se demuestra el método para mantener la posición correcta el periódo de convalescencia. Se enumeran las precauciones que el cirujano debe tomar para la ejecución apropriada del procedimiento y los errores que deben esistarse.

REFERENCES

1. Neer, C. S.; Brown, T. H., and McLaughlin, H. L.: Fracture of the Neck of the Humerus with Dislocation of the Head Fragment, Am. J. Surg. 85:252-258, 1953.
2. Watson-Jones, R.: Fractures and Joint Injuries. Baltimore: The Williams and Wilkins Company, 1944. 1st ed.
3. Michaels, L. S.: Comminuted Fracture-Dislocation of the Shoulder, J. Bone & Joint Surg. 26: 363, 1944.
4. Key, J. A., and Conwell, E.: Fractures, Dislocations and Sprains. St. Louis: The C. V. Mosby Company, 1942. 3d ed.
5. Steindler, A.: The Traumatic Deformities and Disabilities of the Upper Extremity. Springfield, Ill.: Charles C Thomas, Publisher, 1946, p. 123.
6. Speed, J. S., and Smith, H. (editors): Campbell's Operative Orthopedics. St. Louis: The C. V. Mosby Company, 1956. 3d ed.
7. Jones, L.: The Shoulder Joint: Observations on the Anatomy and Physiology, with an Analysis of a Reconstructive Operation Following Extensive Injury, Surg., Gynec. & Obst. 75:433, 1942.
8. Neer. C. S.: Articular Replacement for the Humeral Head, J. Bone & Joint Surg. 37-A:215, 1955.
9. MacAusland, W. R.: Endo-prosthesis for Joint Lesions., Clin. Orthop. 6:37-46, 1956.
10. Gilfillan, C.: Replacement Prosthesis in Shoulder Injuries, Am. J. Surg. 91:900, 1956.
11. Judet, R.; Judet, J., and LaGrange, J.: Arthroplastie de l'epaule par prosthese acrylique, Rev. de chir. 72:129-146, 1953.
12. Krueger, F. J.: Vitallium Replica Arthroplasty on Shoulder, Surgery 30:1005-1011, 1951.
13. Fellander, M.: Fracture-Dislocations of Shoulder Joint, Treated by Excision of Humeral Head and Insertion of Acrylic Prosthesis, Acta chir. Scandinav. 107:138, 1954.
14. Böhler, L.: The Treatment of Fractures. New York: Grune and Stratton, Inc., 1956, vol. 1. Compere, E. L.; Compere, C. L., and Banks, S. W.: Pictorial Handbook of Fracture Treatment. Chicago: The Year Book Publishers, Inc., 1952.
15. Badgley, C. E.: Symposium on Femoral Head Prosthesis, J. Bone & Joint Surg. 38-A:410, 1956.

ADDITIONAL SOURCE

Smith, F. M.: Fracture Separation of the Proximal Humeral Epiphysis, Am. J. Surg. 91:627, 1956.

The Prosthetic Team and the Child Amputee

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THE prosthetic team has been devised in order to make the best use of the surgical and technologic advances in amputation surgery and prosthetics developed during and after World War II. It is now realized that the surgeon's responsibility to the amputee embraces more than performance of a technical procedure. Prior to operation, the surgeon must prepare the patient mentally as well as physically for his ordeal. He must help the patient face his loss with maximum equanimity. With the aid of the prosthetic team, he must make certain that the patient obtains the artificial limb most useful to him, learns to use it with the maximal efficiency and regains his place in society as soon as possible. The patient, the surgeon, the limb fitter and the amputee trainer comprise the basic prosthetic team. Augmentation of the team by the engineer, the psychiatrist, the social service worker and the employment counselor[1] will frequently increase its effectiveness (see diagram).

When the amputee is a child, the prosthetic team is even more important. It must include one or both parents or other relatives, the pediatrician and ideally the child's teacher. Improved devices now permit the fitting of many more children with functioning artificial arms and legs than was formerly possible. Fitting without training, and training without acceptance by the patient, his family and his contemporaries are futile.[2]

The pioneer work of the juvenile training center of the Michigan Crippled Children's Commission[3] has shown that children can be successfully fitted at a much earlier age than was formerly deemed practicable. They (and we) are now fitting selected amputees (both upper and lower extremity) during the first year of life.

The Child Amputee Prosthetic Program at the University of California, Los Angeles,* is conducted jointly by the Medical School and the College of Engineering. The Medical School is responsible for diagnosis and treatment of the medical problems of each patient. The Prosthetic Laboratory of the College of Engineering is concerned with the development and fabrication of prostheses, including special devices that may be indicated for the individual patient. Within the Medical School the departments of orthopedics, pediatrics, psychiatry, physiology, physical medicine and social service participate in the project. Aid is requested from other specialties when needed. Children are "worked up" first by pediatricians. They and their parents are then interviewed by the social service worker and the psychologist. The purpose and operation of the program is explained to them by the project administrator. The patient is examined by the prosthetist, if the problem presents any complication, and is introduced to the trainer. Not until these steps have been completed does the patient appear at the amputation conference.

At this meeting the orthopedic surgeon, the pediatrician, the engineer, the psychologist, the amputee trainer, the prosthetist

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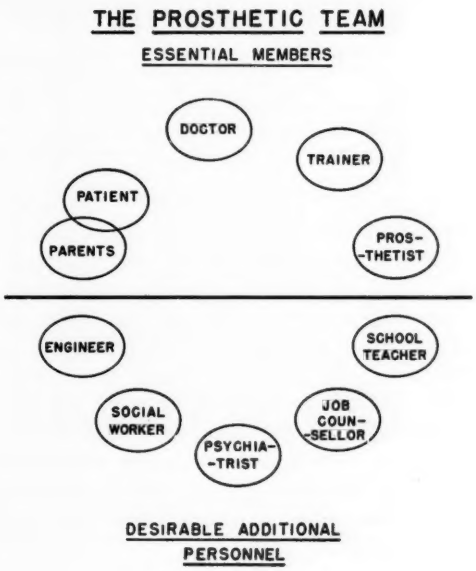
and the social service worker report their impressions of the child's problem, and a group decision as to the best course of therapy is reached. This may be preprosthetic physical therapy or other treatment.

If the patient is judged ready for a prosthesis, it is prescribed. After its fabrication the device is checked for fit and function, and training in its use is provided. The child returns to the amputation conference at intervals of three to six months for review of his progress. If repair or a replacement of the prosthesis is necessary, it is ordered. If further training, psychologic help or other therapy is indicated, this is prescribed.

The children examined by the UCLA group have presented all manner of deformities. In some the loss may be as little as one or more digits. The foot or hand may be functional, or it may be deformed and have little or no function. The site of amputation may be at any level. The deformity may be a malformation of the extremity rather than an amputation. Since treatment varies according to the type of deformity as well as the age of the patient, we have arbitrarily divided the deformities into two categories, complicated and uncomplicated. If the anatomic and functional status of the extremity proximal to the level of amputation or deformity is normal, or nearly so, the deformity is classified as uncomplicated (Birch-Jensen exogenous group)[4]. Surgical intervention here is rarely indicated except to ablate functionless vestigial digits, which may be cosmetically offensive or may interfere with the function of the prosthesis. Traumatic amputations are included in this group, since the fitting problems are similar. Present prosthesis knowledge permits the fitting of functional artificial limbs at any level above the carpal and tarsal areas. There are no "sites of election" in the upper extremity. All possible length should be preserved.[5] Fitting and fabrication in these cases is usually not difficult. Acceptance of the device and training in its use may offer more serious problems. The services of a psychiatrist, a trainer, a social service worker and a teacher may be necessary.

In some instances phocomelia and some other types of deformity are rather grotesque, with ill-formed and distorted terminal segments. These are frequently accompanied by dysplasia of the hip or shoulder joints, short femurs or humeri, limited function of the knee or elbow and divers muscular anomalies. Such deformities we have designated complicated (Birch-Jensen endogenous group).[4] Fitting is more difficult. Impaired function of the extremity invariably makes control and use of the artificial limb a greater challenge to the prosthetic team than the uncomplicated deformity. Our ability to help these people is limited. Further study and investigation of their problems is necessary.

Surgical intervention for complicated deformities is most frequently indicated



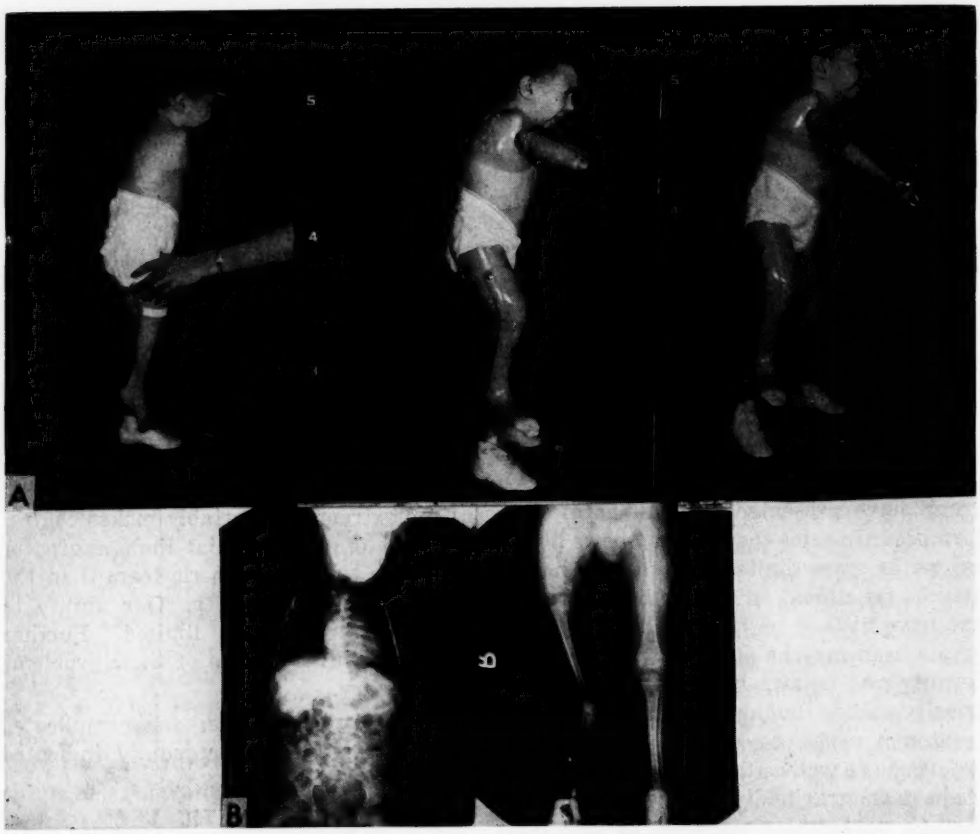


Fig. 1.—*Above, left,* absence of upper extremities and deformed short right lower extremity. *Below,* roentgenogram showing absence of upper extremities, scoliosis, dysplasia of right hip, short bowed femur, absence of fibula and maldevelopment of foot. *Above, center,* plastic extension prosthesis for right lower extremity and pylon type device with shoulder cap, passive shoulder motion, and no terminal devices for the upper extremities. *Above, right,* passive shoulder and elbow joints for upper extremities. The right terminal device is a hook, the left an infant passive hand.

to rid the patient of a useless part that perhaps requires an unsightly, misshapen socket, may be irritated by the wearing of a prosthesis or may interfere with function. One should, however, maintain a conservative approach to operation. As a rule it is better not to remove the anomalous part until the patient requests the operation. One should preserve epiphyses and joint function at operation whenever possible. We have not advised cineplasty before the age of 15 unless some very unusual condition exists.

There is one particular type of deformity—it may be either uncomplicated or complicated—with which experience has recently taught us to restrain our enthusiasm and adopt a more cautious approach. This is the bilateral type in which the level of amputation is near the shoulder joint or in which the deformed extremities are short and have limited function.

The prosthetic tolerance of such people does not permit fitting them with prostheses of the bilateral shoulder disarticulation or the short above-elbow type. It is not

possible to harness them so that independent action of each artificial arm is achieved. There is insufficient scapular motion to permit it. We have reluctantly concluded that it is better to make a single device for them and teach them to use it well.

REPORT OF CASES

CASE 1.—C. J., a 38-month-old boy, was initially seen in Amputation Conference on December 1953, with scoliosis, complete absence of both upper extremities, and a deformity of the lower part of the right extremity (Fig. 1), which showed dysplasia of the hip, malformation of the femoral head, bowing of the shaft, absence of the fibula, a 20 degree flexion contracture of the knee and a maldeveloped foot. He was a bright, cheerful, cooperative child with a high intelligence quotient who was, and has remained, exceptionally well adjusted. He had developed remarkable dexterity with the normal left foot. There was some speculation as to the advisability of depriving him of the function of this member for writing and holding. He was encouraged to wear an easily removable shoe. We were uncertain as to what type of device might be useful for the upper extremities. Ambulation seemed the most pressing problem; therefore we prescribed for it first. The child was given a pylon of the crutch type for walking. Multiple plaster therapy to obtain full extension of the knee and better position of the foot, with exercises to develop the muscles of the shoulder girdle, were prescribed. Later a plastic extension type of prosthesis was provided for the lower part of the right extremity. Two years after the first visit, when the boy was 5 years old, some self-confidence had been developed. Bilateral arm prostheses of the pylon type, with passive friction shoulder joints and no terminal devices, were supplied (Fig. 1*C*). One month later he was given bilateral articulated prostheses with passive friction shoulder and elbow joints (Fig. 1*D*). The right terminal device was a passive 10x hook; the left, an infant passive hand. Three months later the boy walked well and ran a few steps. Conventional cable control to activate the right hook was prescribed.

Sporadic periods of interrupted training, because of transportation difficulties and nonwearing of the arm prostheses at school have retarded good prosthetic function in this case. Inpatient training would probably have been more efficacious. Arrangements are being made for training sessions at school for this boy. The probability of his becoming a good user of bilateral prostheses is not the best, but we wish to give him every advantage. He will probably develop into a "single-arm wearer." Eventual Syme amputation of the right foot is anticipated.

This case depicts an effort to help a badly handicapped child. Our lack of self-confidence and knowledge of how to proceed delayed the fitting of prosthetic devices for the arms. We have been extremely gratified by his excellent use of the leg prosthesis and are hopeful of pro-

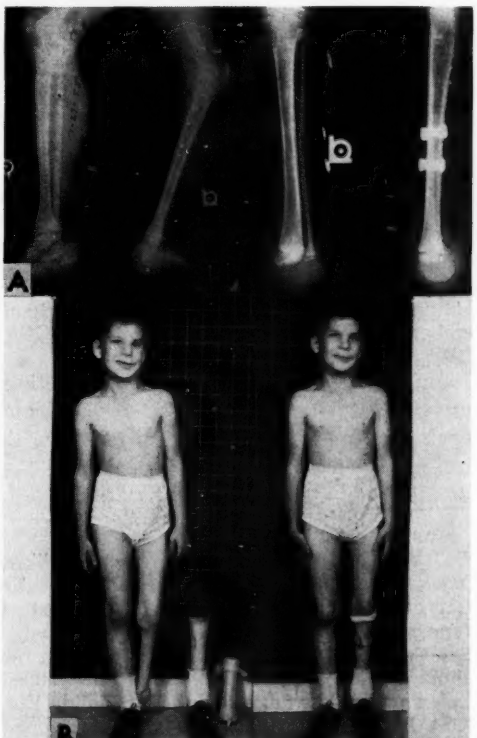


Fig. 2.—*A*, roentgenograms showing shortening of left tibia, calcaneus and underdevelopment of foot (*left*) and Syme stump (*right*). Note preservation of distal tibia and fibular epihyses. *B*, healed Syme stump (*left*) and patient wearing prosthesis (*right*).

viding a degree of useful upper extremity function. He demonstrates the fact that children will use artificial extremities that provide comfort and function. In this instance the engineer was essential in providing special devices, the prosthetist in their fabrication and the trainer in teaching their use. The surgeon will make his contribution later.

CASE 2.—M. S., a 6-year-old boy with a congenital deformity of the left leg and left facial paralysis, was seen initially in November 1954 (Fig. 2*A*, left). Considerable improvement in the position of the left foot had previously been obtained by wedge plasters and by transplantation of the tibialis anticus to the os calcis. Attempted stimulation of the lower femoral and upper tibial epiphyses by insertion of screws had been of doubtful benefit. The leg remained 4 inches (10 cm.) short. Amputation of the deformed foot was advised the following summer. A Syme procedure, with preservation of the distal tibial and fibular epiphyses, was done eight months later (Fig. 2*A*, right), and the wearing of a prosthesis commenced four months after the operation (Fig. 2*B*). Meanwhile, exercises to develop weak gluteal muscles, hip rotators, abductors and adductors and the quadriceps were being performed. When seen after wearing the prosthesis for six months he ran, jumped and played without embarrassment with others of his age (Fig. 2*B*).

In this instance a difficult and rather unsatisfactory fitting problem was converted into a simple fitting problem, with improved function, by extirpation of the distal part.

CASE 3.—G. W., an 8-month-old boy, was first seen in November 1953, with the following congenital deformities: (1) Disarticulation of the right knee with bifid lower part of femur; (2) amputation of the right arm below the elbow, with a single ray distal to the short ulna; (3) left clubfoot, and (4) webbed index and middle fingers of the left hand (Fig. 3, *A B*).

The clubfoot was corrected by multiple wedge plasters. The child was given a jointless pylon leg prosthesis at the age of 10 months and used it well at the age of 1 year. The femoral exostosis and the vestigial right hand were surgically removed. When the child was 15 months old a short (below the elbow) prosthesis and an infant passive hand were supplied (Fig. 3*C*), which he quickly learned to use for pushing and pulling. At 19 months he could pull himself upright and walk a few steps unassisted. He voluntarily brought his prosthesis (upper) to be put on. At 23 months the passive hand was replaced by a small hook and the pylon by a fully articulated artificial leg (Fig. 3*D*). At 32 months the boy used both prostheses voluntarily and easily. He vociferously resented having them taken off, demanding their immediate return.

This case represents an effort at early fitting of lower and upper artificial limbs. The engineer and all the members of the basic prosthetic team contributed. The child responded enthusiastically. We hope that a symmetric body will develop and that he will thus avoid some of the psychic problems others of the children have exhibited. He has already demonstrated good acceptance and use of his prostheses.

CASE 4.—G. M., a boy aged 37 months with a disarticulated left elbow, was seen in Amputation Conference in October 1954. Amputation had been done two months earlier for a fibrosarcoma, which had eroded much of the ulna and some of the radius (Fig. 4, *A* and *B*). Five months after the operation the boy was given a standard prosthesis for disarticulation of the elbow[5] with an 88x hook (Fig. 4*C*). His adjustment to this devise was extremely good, and he readily became a good functional user. At first he was unable to operate the adult-sized outside locking hinge, but he has since become proficient. He is an enthusiastic archer (Fig. 4*D*). He was last seen at the age of 57 months, at which time the recently developed child's outside locking elbow hinge was prescribed. Roentgenograms of the stump and chest at intervals of six months have shown no evidence of tumor.

In this instance, function of a prosthesis for elbow disarticulation in a small boy was impaired by lack of properly sized elbow mechanism. Despite this handicap, the device has been useful to him. The feasibility of fitting prostheses at this age level is demonstrated.

CASE 5.—M. B., a boy aged 21 months with congenital webbing of the right ring and mid-

Fig. 3.—*Above*, roentgénograms showing (left to right) right upper extremity with single, short forearm bone and single vestigal finger; left upper extremity with webbing of index and middle fingers, and bifid right femur and knee disarticulation. *Below* (left to right), photographs showing short right below elbow, and knee disarticulation stumps: pylon type right lower prosthesis and short below elbow device with infant passive hand; articulated right artificial leg and actively controlled hook.

dle fingers, four metacarpals, from the second of which two fingers arose, an undeveloped thumb that functioned as a unit with the index finger and, on the left, a short malarticulated bifid humerus with a small hand-shaped functionless appendage distal to it, was seen in March 1955 (Fig. 5, *A* and *B*). He was provided with a modified prosthesis for use above the elbow, which was fixed at 135 degrees and a 10x hook for the left side (Fig. 5*C*). His neuromuscular development was insufficient to permit a satisfactory hook opera-

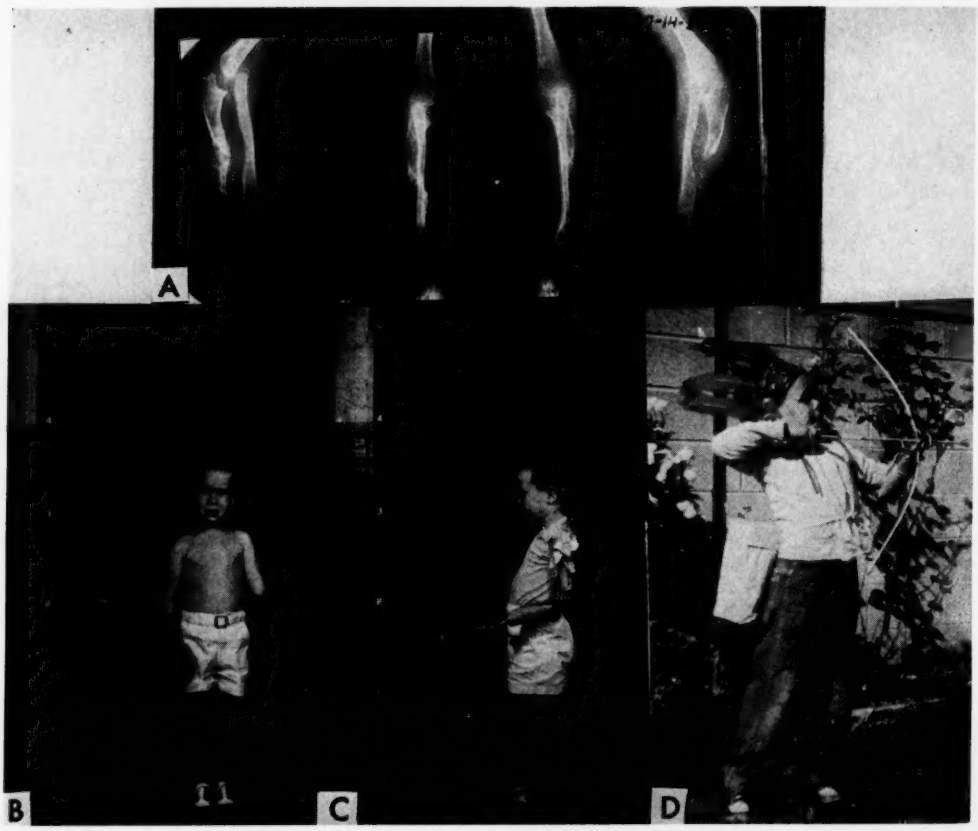


Fig. 4.—*A*, preoperative roentgenograms showing large tumor of left forearm with destruction of lower part of ulna and pressure necrosis of mid part of radius. *B*, disarticulation of left elbow. *C*, prosthesis for disarticulation with outside locking elbow joint. *D*, patient at archery practice.

tion; an infant passive hand was therefore substituted. He obtained good push-pull function from this until he outgrew the prosthesis, eight months after his initial visit. At the age of 33 months the spur on the bifid left humerus was removed and the webbed fingers of the right hand separated. At 37 months there was surprisingly good flexion and abduction of the left shoulder (90 degrees). A new prosthesis with a passive friction elbow lock was prescribed. A small hook will be used, as it is our opinion that he will now be able to operate it.

This is an instance in which the early fitting of special prostheses in a complicated case was helpful. At the time of the initial fitting the child was too young to operate a hook. The passive hand was more nearly physiologic. He will need continued training for a considerable period. We anticipate the development of helpful function in the left arm. Two minor surgical procedures proved beneficial; others may be necessary to improve the function of the left shoulder and the right hand. In this case also the engineer and the basic prosthetic team all contributed to the result.

CASE 6.—N. B., 14-year-old boy, a self-reliant, uncommunicative Indian football, baseball and basketball player, tore off a considerable portion of his left hand by an accidental shot-

gun discharge on Sept. 10, 1955. He walked about half a mile to his home. Circular amputation 1½ inches (3.2 cm.) above the wrist was done (Fig. 6*A*). He exhibited almost immediate depression and talked of suicide. Six days after the injury he was transferred to the University Hospital. Seventeen days after the injury, secondary closure was accomplished. Periods of marked depression continued. The boy was concerned about his athletic and social future. At times he wished he were dead. Letters from many friends made little difference. He suffered the usual phantom sensations without pain. He was not interested in wearing prostheses. He remained withdrawn and depressed, despite all efforts of the staff.

A standard long below-elbow prosthesis, with hand and hook, were delivered ten weeks after the amputation (Fig. 6*B*). One week of training was given. During the ensuing month the boy played in a school basketball game without the prosthesis and "didn't miss a basket." He did wear the hook for occasional activities about the house, but he refused to wear a prosthesis outside his home. Ten months after the injury he had still not accepted the device as useful. This was because of his self-consciousness when he wore it and because he could not use it in organized team sports. He did wear the hook for such activities as mowing and raking the lawn.

This case illustrates the profound psychic trauma that may accompany surgical amputation and the refusal to accept a prosthesis unless it has functional value. The boy's relatively long stump, apparently, is not so much a physical as a psychic handicap. Psychiatric therapy has been minimal, since it is not available in the boy's small home community three hundred miles distant. The social worker and the high school principal have helped to alleviate his mental distress. In our opinion, this boy would have been better off had forearm rotation and additional length been preserved by distarticulation of the wrist, which was surgically feasible. The psychiatrist, social worker and school principal augmented the prosthetic team in this instance.

CASE 7.—M. A. L., a girl aged 10½ with a very short congenital amputation of the right arm below the elbow was seen for the first time in May 1953 (Fig. 7*A*). She had developed remarkable dexterity in the incomplete member. A prosthesis (Fig. 7*B*) with a step-

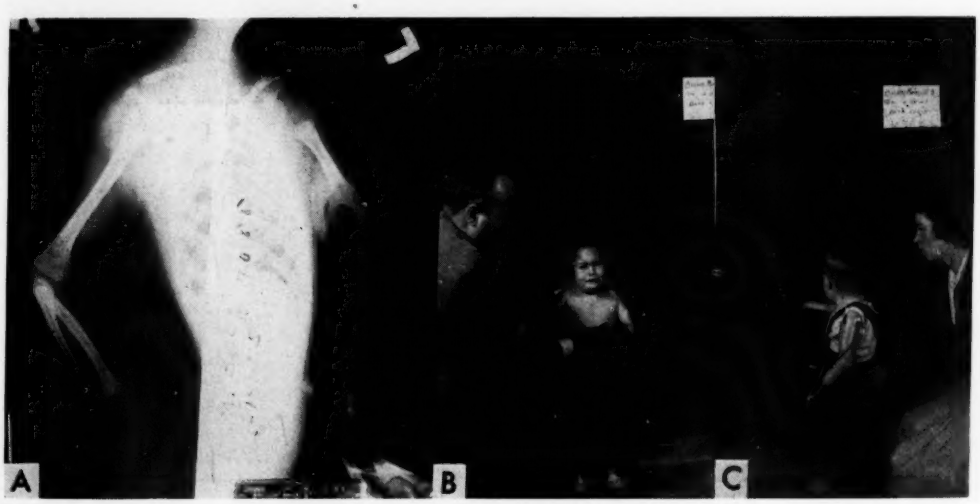


Fig. 5.—*A*, roentgenogram showing dislocation of left shoulder, short bifid humerus and vestigal hand and, on right, four metacarpals with two fingers rising from the second metacarpal. *B*, photograph of deformed left upper extremity. *C*, left prosthesis, with elbow fixed at 135 degrees, and small hook.

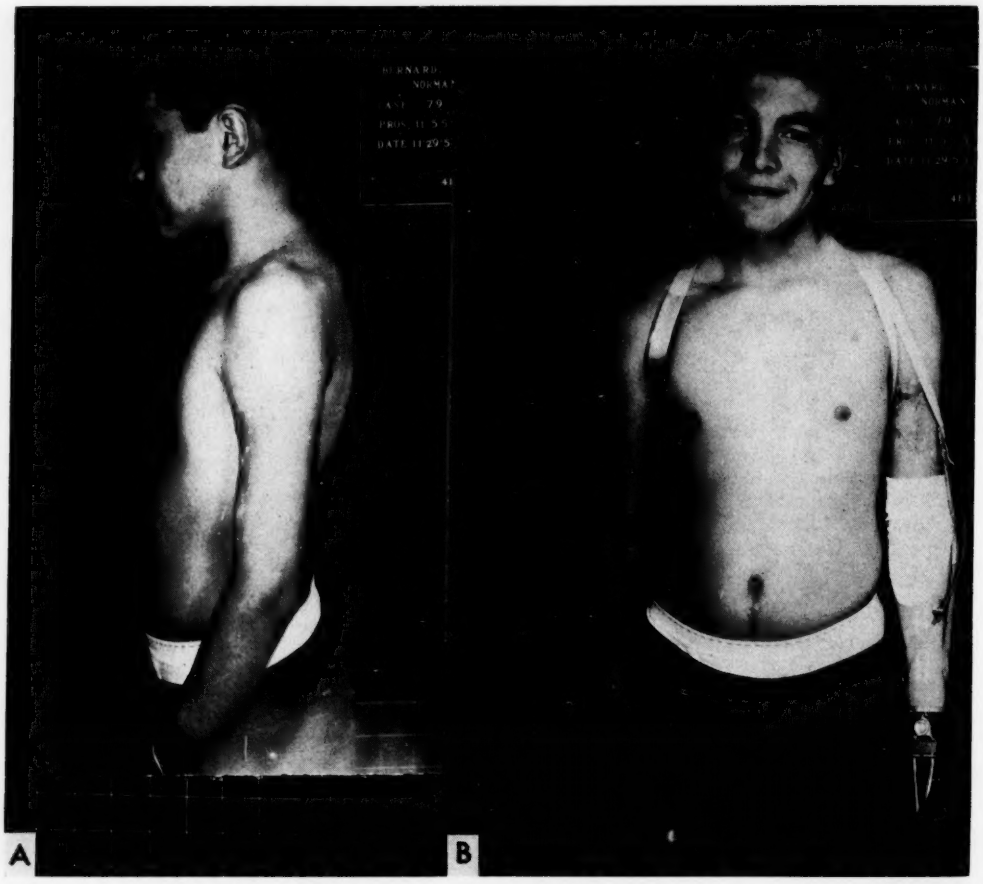


Fig. 6.—*A*, amputation left long below elbow. *B*, standard long-below-elbow prosthesis with hook.

up hinge was provided but did not enlarge her sphere of activities appreciably. On several occasions she expressed resentment at the teasing and questioning her deformity elicited from other children. She was not interested in learning how to operate a prosthesis skillfully. Twenty months later she used the hook sometimes for household tasks and piano playing, with a special terminal device for the latter, but she rarely wore it outside. At this time an APRL hand, interchangeable with the hook, was supplied. She wears the hand infrequently for social activities. She remains essentially a conscious "wearer" as contrasted to a natural "user." Her attitude might be different if she had a smaller hand.

This child, at the age of 10½, had become too proficient with substitute mechanisms to be enthusiastic about wearing a hook, even though it enabled her to do certain tasks more easily. Had she started at the age of 1½ she might have done better. She reflected minimal psychic disturbance from criticism by others. With a functional hand, she occasionally used the prosthesis as a social adjunct. The need for smaller hands is evident here (Fig. 7*C*).

Fitting.—A child instinctively makes maximum use of his own limit, whatever its inherent defect. He will use an artificial limb only if it provides comfort and function. In the weight bearing extremities it is relatively easy to furnish him

functional prostheses at any level of loss. Suction socket wearing in the fourth year is generally feasible. We know of 1 instance of successful fitting at the age of 15 months. Absence of a portion of the upper extremity, particularly distal to the elbow, is compensated for by the congenital amputee to a remarkable extent. He must be convinced that improved function will outweigh the inconvenience of wearing a prosthesis (Cases 6 and 7). We do not prescribe functionless hands on a cosmetic basis.

Decision as to the optimum time for fitting the child and the type of apparatus prescribed are based on several factors: (1) the level and nature of the amputation; (2) the age of the patient, and (3) the attitude of the child and his parents toward the wearing of prostheses.

The level and nature of amputation determine to a considerable extent the type of prosthesis prescribed.[5] The prescription must be modified according to the patient's age. Neuromuscular development of the infant permits only gross motions.

A child begins standing and walking at about the end of its first year. He should be given something to stand on. Initially this may be a jointless pylon (Case 3). When good balance is attained an ankle can be added, and at about the age of 3 he can probably operate a knee joint.

At to the upper extremity, a child under a year of age can push and pull only, so the infant passive hand is used (Cases 3 and 5). The mother can pre-set a passive elbow (Case 1). At the age of approximately 2½ years the child will have developed sufficiently to operate a small hook. Two-handed activities away from the body are thus provided. Not until he approaches the age of 4 is the child able to understand the mechanics of a fully functioning prosthesis and to make active use of it.

Training.—As yet there is no unanimity

Fig. 7.—*A*, very short-below-elbow amputation on right. *B*, prosthesis with hook. *C*, prosthesis with adult functional hand, which is larger than patient's normal hand.

of opinion as to whether inpatient or outpatient training is the more desirable. The Michigan group has an inpatient program. Ours is of the other type. Both groups recognize the necessity for adequate training. The individual needs of the patient often require highly individualized training technics (Cases 1, 3 and 5), but group training of children with similar handicaps at various age levels has been profitable, since competition and mutual interests are favorable factors within such small groups. Parental training is a valuable adjuvant. The school authorities can likewise be helpful, through encouragement of the amputee and in obtaining his acceptance by his classmates as an equal member of the community.

The psychic disturbance occasioned by absence or loss of a member is of greater consequence in many children than it appears on superficial study (Case 6). Formation of an amputated self-image, if it persists too long, militates against the acceptance of prostheses (Case 7). Parental feelings of guilt and desire to hide the deformity or the prosthesis may be unconsciously absorbed by the child and render acceptance more difficult. In such instances psychotherapy for both patient and parent becomes an integral part of the training program. We have organized a discussion group for parents in which they can talk over common problems.

SUMMARY

The study, fitting and training of 100 child amputees has convinced the authors that their problems are best solved by a team approach.

A definite training program is needed. This should be augmented by parental training at home and by the cooperation of school authorities and playmates. Adjuvant psychotherapy is demanded in certain instances.

Regular follow-up visits are mandatory to maintain maximum fit and function of prostheses, and to prescribe further training or other therapy when indicated.

Children can be successfully fitted with lower extremity prostheses when they commence to ambulate, with devices for the upper extremity during their first year. The prosthesis must provide comfort and function.

RÉSUMÉ

L'étude, la préparation et l'entraînement de 100 enfants amputés a convaincu les auteurs que leurs problèmes ne peuvent être résolus que grâce à un travail d'equipe.

Un programme d'entraînement bien défini est nécessaire. Celui-ci devrait être complété par les parents à la maison et par la collaboration des autorités scolaires et des camarades de jeux. Dans certains cas une psychothérapie adjuvante est indiquée. Ces enfants doivent être suivis à intervalles réguliers afin de contrôler l'adaptation fonctionnelle des prothèses et de prescrire l'entraînement et la thérapeutique à poursuivre.

Des prothèses des membres inférieurs peuvent être adaptées avec succès chez les enfants dès qu'ils deviennent ambulatoires. Les appareils des membres supérieurs sont applicables durant la première année. Une bonne prothèse procure un réconfort moral en assurant une activité fonctionnelle.

RESUMEN

El estudio, preparación y entrenamiento de 100 niños amputados ha convencido a los autores, que esos problemas son lo mejor resueltos por un grupo entrenado.

Un programa definitivo de entrenamiento es necesario. Esto debería ser incrementado por el entrenamiento de los padres en casa y por las autoridades de la escuela y compañeros. Psicoterapia coadyuvante es solicitada en ciertos casos.

Ahinco continuo es necesario para mantener el adecuado optimum y función de prótesis y como una oportunidad para prescribir más adelante, entrenamiento o terapéutica cuando está indicada.

Los niños pueden tener éxito con prótesis para las extremidades inferiores cuando ellos lleguen a ser ambulatorios. Aparatos para las extremidades superiores pueden ser aplicados durante el primer año. El éxito de la prótesis provee comodidad y función.

RIASSUNTO

Lo studio di 100 bambini amputati ha dimostrato all'autore che il problema della loro riabilitazione deve essere risolto in collaborazione.

E' necessario fare un programma preciso per la rieducazione: questo deve essere integrato dai famigliari, a domicilio, e dagli insegnanti nella scuola. In certi casi è necessaria anche la psicoterapia.

Controlli periodici sono indispensabili per mantenere il massimo di efficienza fisica e delle protesi, e si devono prescrivere ulteriori periodi di allenamento quando sia necessario.

I bambini vengono forniti di protesi per gli arti inferiori non appena cominciano a camminare, mentre le protesi per gli arti superiori vengono applicate fin dal primo anno. Le protesi efficienti danno benessere e buoni risultati funzionali.

ZUSAMMENFASSUNG

Die vorliegende Untersuchung erstreckt sich auf die Ausrüstung und Ausbildung hundert amputierter Kinder und bringt die Verfasser zu der Überzeugung, dass die Probleme der Patienten am besten durch eine zusammen arbeitende Gruppe gelöst werden können.

Ein ausgesprochenes Programm der Ausbildung ist notwendig. Dieses muss durch Trainierung seitens der Eltern zuhause und durch Mitarbeit der Schulbehörden und der Spielkameraden ergänzt werden. In manchen Fällen ist eine unterstützende Psychotherapie erforderlich.

Um den bestmöglichen Sitz und die beste Funktion der Prothesen zu erzielen, und um Gelegenheit zur Verschreibung weiteren Trainings oder zusätzlicher Behandlung zu haben, sind regelmässige Besuche zur Nachuntersuchung unerlässlich.

Wenn die Kinder das Alter des Laufens erreichen, können ihnen Prothesen für die unteren Extremitäten mit Erfolg angepasst werden. Prothesen für die oberen Extremitäten lassen sich während des ersten Lebensjahres anwenden. Eine Prothese ist erfolgreich, wenn sie bequem ist und Funktion gestattet.

SUMARIO

O estudo da recuperação e treinamento de 100 crianças amputadas leva os AA. a concluir que os seus problemas são melhor resolvidos quando em trabalho de equipe.

É necessário um programa de treinamento difinitivo. Este plano é ampliado pelo treino com auxilio dos familiares e pela colaboração das autoridades escolares e pelos companheiros. A psicoterapia auxiliar é requerida em certos casos.

A revisão regular durante o seguimento é obrigatória para manter a forma físico ótima e a função das ptóteses e, também, como uma oportunidade para prescrever treinamento adicional ou terapêutica, quando indicados.

As crianças podem ser bem recuperadas com o uso de proteses para os membros inferiores no momento em que iniciam a deambulação. Improvisacões bem conduzidas podem ser aplicadas aos membros

superiores durante o primeiro ano. A prótese correta fornece conforto e função.

REPERENCES

1. Brooks, M. B., and Mazet, R. Jr.: Prosthetics in Child Amputee, Clin. Orthoped. 8, 1956.

2. Kessler, H.: The Management of Congenital Amputations, Proc. Kessler Inst. for Rehabilitation 1:26, 1953. Lambert, C. N.: Upper Extremity Prosthesis in the Juvenile Amputee, J. Bone & Joint Surg. 38A:421, 1956.

3. (a) Aitken, C. T., and Frantz, C. H.: The Juvenile Amputee, J. Bone & Joint Surg. 38A: 659, 1953. (b) Aitken, C. T., and Frantz, C. H.: Prostheses for the Juvenile Amputee, Am. J. Dis. Child. 89:137, 1955. (c) Frantz, C. H.: Prosthetic Problems in the Juvenile Amputee, Orthoped. & Prosthet. Appliance J. 6:12, 1952. (d) Frantz, C. H.: Child Amputees Can Be Rehabilitated, Children 3:61, 1956. (e) Steersma, J.: Training the Juvenile Amputee, Orthoped. & Prosthet. Appliance J. 6:18, 1952. (f) Waddell, J., and others: Training Child Amputees, The Crippled Child, 1951.

4. Birch-Jensen: Congenital Defects of the Upper Extremity. Copenhagen: Ejnar Nunkegnard, 1949.

5. Mazet, R.; Taylor, C. T., and Bechtol, C. O.: Amputation Surgery and Prosthetic Prescription, J. Bone & Joint Surg., to be published.

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Solitary Cyst of the Os Calcis in Adults and Children

Report of Eight Cases

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THIS lesion of bone is usually detected incidentally after roentgenograms have been taken for signs and symptoms referable to other parts of the foot or to the ankle. In a small percentage of cases symptoms of pain in the heel on weight bearing and mild tenderness in the same area may lead one to suspect solitary cyst.

Incidence.—According to the literature the average age of the patient at the time of occurrence or of diagnosis is approximately 15 years. The lesion is somewhat more common in the male than in the female, although in 4 of the cases here reported the patients were 9 years of age or younger, and the sex distribution was equal among these.

In 1877 Virchow first described solitary bone cyst in a tubular bone, but not of the os calcis. In 1931 J. R. Moore listed 32 cases of tumor of the os calcis at Johns Hopkins Hospital but observed no bone cysts in these. He noted mention of 4 such cysts in the literature of the previous fifty-one years.

Of 1,740 bone tumors listed at the Johns Hopkins Hospital in 1931, 2 per cent involved the os calcis.

In 1932, Coley and Sharp stated that benign bone cyst in the os calcis is exceedingly rare.

N. R. Smith reported 1 case of solitary cyst of the os calcis in 1930; Sobel and Beclere, 1 case each in 1936, and Fitte and Mulcahy, 4 unproved (?) cases in 1939. In 1943, McLaughlin described 1 case in a series of 26 cases involving various bones. Copleman, Vidoli and Crimmings reported 3 cases in 1946, in 2 of which surgical treatment was employed. Janes reported 1 case in 1946 and Verstandig 1 case in 1947.

In 1950, Meyerding and Jackson reported 1 case of a lesion diagnosed as giant cell tumor, though with a picture similar to that of solitary or unicameral cyst. They noted that the lesion probably corresponded to the unicameral cysts of the os calcis reported by others (Copleman; Vidoli and Crimmings; Janes; Dunn; Jaffe and Lichtenstein).

Stewart and Howel in 1950 reported a series of 46 solitary bone cysts or "regressive osteoclostomas," 4 of which were in the os calcis. The average age of the patients was 15 years. About 65 per cent were male.

Etiologic Theories.—To my knowledge, no final agreement has been reached as to the cause of these lesions.

Geschicter and Copeland expressed the opinion that solitary bone cyst represents the healing or healed stage of giant cell tumor. Coley and Higinbotham suggested that these cysts probably begin with a subcortical hemorrhage followed by localized bone destruction, a zone of vascular granulation tissue in which osteoclasts (giant cells) are present, then fibrosis, and finally cyst formation.

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Freund and Meffert suggested that the lesion is a regional form of osteitis fibrosa cystica, is monostotic, monomelic or unilateral and is due to a congenital defect in bone development.

In 2 of my cases of bilateral cyst of the os calcis in children there were associated congenital defects, which in some respects may support the theory of a congenital origin.

Other causes considered are (1) faulty calcium metabolism, although the serum calcium level is usually normal; (2) inflammation; (3) abnormal hyperplasia of osteoclasts as aforementioned in reference to the work of Geschicter and Copeland, who also suggested that regressive osteoclastasia occurs in bone cysts and progressive osteoclastasia in giant cell tumor, and (4) central bone tumors with cystic softening. It is known that lesions of the cystic type may be associated with a number of different bone tumors, but in my opinion these are usually not typical of the solitary cyst of the os calcis.

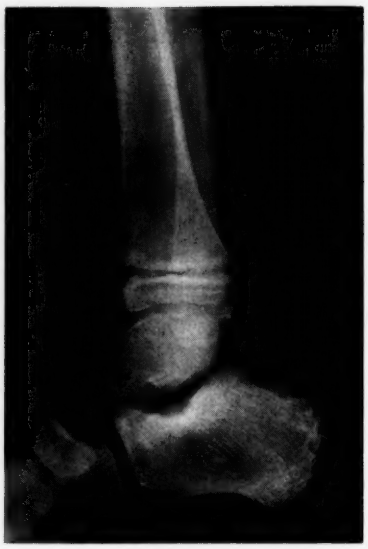

Fig. 2 (Case 2).—Early cystic formation of os calcis (right).

Fig. 1 (Case 1).—*A*, lateral roentgenogram of right foot, showing early cystlike lesions of os calcis. *B*, left foot.

Diagnosis.—Briefly, this depends chiefly on roentgen signs, plus essentially normal levels of blood calcium, phosphorus and alkaline phosphatase, and partly on biopsy (the specimen is not entirely typical of any pathologic lesion but serves to rule out many). For details of the pathologic picture of solitary bone cysts (of various bones) I refer the reader to Stewart and Howel. My own pathologic observations on these cysts, based on only a few cases, are as follows: loose osteoid tissue, a moderate number of fat cells, and a moderate number of giant cells, which are not conclusive evidence of any particular bone lesion (see photomicrograph of biopsy specimen). Symptoms, such as pain in the heel on weight bearing, may occur but are not conclusive.

Space does not permit a discussion of the differential diagnosis, but among le-

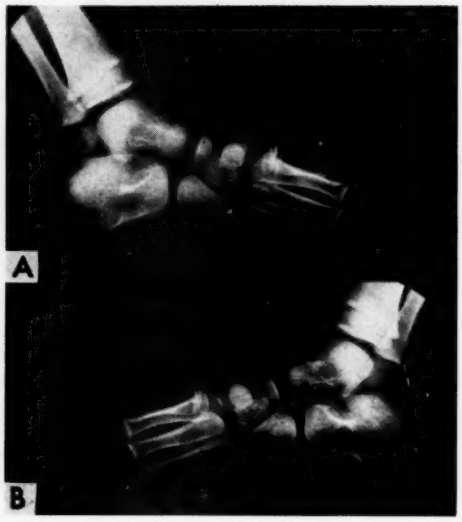

Fig. 3 (Case 3).—Cyst formation of both os calces, with macrodactylism.

sions to be considered are giant cell tumor, Brodie's abscess, various malignant bone lesions with cystic changes, fibrous dysplasia of bone (with cystic degeneration), osteitis fibrosa, and enchondroma and gumma of bone.*

REPORT OF CASES

CASE 1.— M. H., a 9-year-old white girl, was seen in the clinic of the Orthopaedic Hospital, Los Angeles, on April 18, 1947, with complaints of pain in the middle part of the foot on walking for the past three months. Examination showed bilateral severe calcaneovalgus, ankle inversion and mild forefoot abduction. The tuberosities of both scaphoids were prominent. Roentgenograms showed "cystlike" formations in the inferior portion of the anterior half of each os calcis (Fig. 1, *A* and *B*) and bilateral os tibiale externum. The cysts probably form one large cyst with large trabeculations separating the parts. "Survey" roentgenograms of other principal long bones were normal, as in all of the cases here reported.

Treatment consisted only of shoe corrections; considerable relief of the pedal symptoms was obtained. No treatment of the cysts *per se* was given.

In this case, the association of os tibiale externum with the cysts suggests a possible congenital origin for the latter.

CASE 2.—J. O. C., an 8-year-old white boy, was first seen on October 18, 1946, for reexamination of a leg for residual poliomyelitis and paralysis of the foot incurred in August, 1946. There were no complaints referable to the foot. On Aug. 1, 1947, the boy was seen again for pain in the right ankle following an injury. Roentgenograms (Fig. 2) showed chip fracture of the right lateral malleolus and early cyst formation in the os calcis (anteroposterior view omitted.)

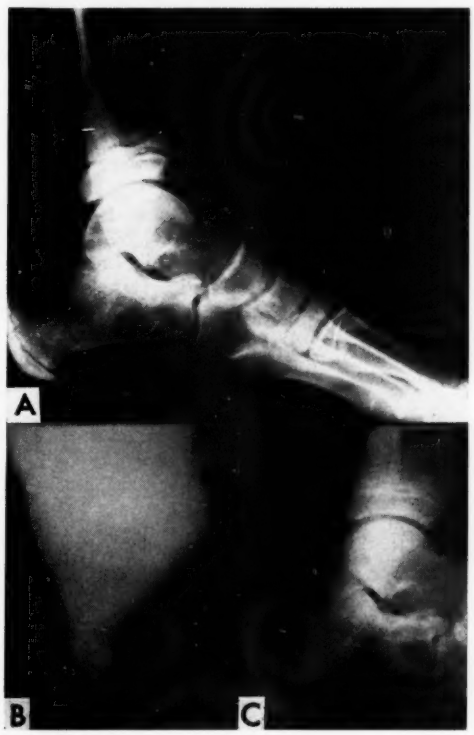

Fig. 4 (Case 4).—*A*, lateral view of left foot, showing area of decreased density in os calcis (Feb. 19, 1947). *B*, slight increase in size of os cyst (Dec. 16, 1947).

*Although I myself have not seen a fracture in a case of solitary cyst of the os calcis and at present can find no report of such a case in the literature, it seems logical that a weakened bony structure in an area frequently subject to trauma should be liable to pathologic fracture. There are probably unreported cases of these. Insurance risks and pension responsibilities in military services might be affected by these lesions, as os calcis fractures often carry a high percentage of disability. The relative infrequency of this lesion, of course, is against its becoming a major problem. The risk of a patient with such a lesion might be considered.

A cast was applied to the right leg, and about two months later the child was essentially normal as to signs and symptoms. No treatment of the cyts *per se* was done.

This case is fairly typical of cysts observed incidentally on roentgenograms taken for other complaints.

CASE 3.—J. A. D., a 4-year-old white girl, was seen in the clinic on Sept. 15, 1947, for macrodactylism of the left second and third toes. There were no symptoms referable to the heel. A roentgenogram (Fig. 3) taken on September 18, showed abnormally increased length and width of the second and third metatarsals and phalanges and cyst formation in both os calces.

Treatment was confined to epiphysiodesis of the proximal phalanges of the involved toes. The cysts themselves were not treated.

This was the youngest patient in the series. Again the cysts were associated with congenital deformity and were fairly well formed at the age of 4 years.

CASE 4.—W. T. H., a 15-year-old white boy, was first seen in the clinic Feb. 17, 1947, with swelling and tenderness of the left side of the ankle and left upper tibial region, following a recent injury. There were no complaints referable to the heel.

Roentgenograms taken on Feb. 19, showed probable fracture of the left tibia into the proximal epiphysis, slight widening of the mortise of the left ankle and a rather sharply outlined area of decreased density void of trabecular markings in the left os calcis, about 1 inch (2.5 cm.) posterior to the calcaneocuboid articulating surface (Fig. 4 *A*).

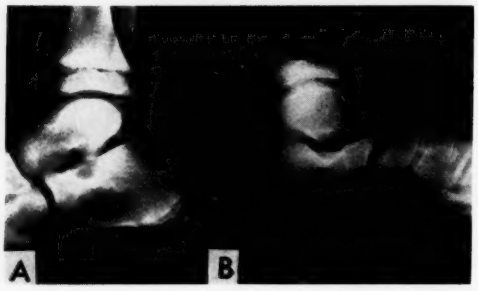

Fig. 5 (Case 5).—*A*, lateral view (Feb. 21, 1948), showing large unicameral type of cyst of left os calcis. *B*, follow-up film (Sept. 25, 1948), showing anterior increase in size of cyst.

Roentgenograms of the opposite os calcis and principal long bones were normal.

Treatment consisted of the application of a long leg plaster cast and was followed by a gradual return to full activity in about five months. Films taken of the foot on December 16, showed a slight anterior increase of size in the cyst of the left os calcis (Fig. 4 *B*).

This case indicates that such a cyst may increase in size; in this instance, in about ten months.

CASE 5.—A. S., a 9-year-old white boy was seen in the clinic in February 1948 for symptoms referable to the left ankle. The mother stated that he had complained eight months earlier of pain in the left heel on weight bearing.

Roentgenograms showed a large cyst of the unicameral type in the left os calcis (Fig. 5 *A*) but no abnormalities of the ankle.

The values for blood calcium, phosphorus, alkaline phosphatase and cholesterol were essentially normal. Urinalysis gave normal results.

The ankle sprain healed well with routine treatment, but a slight increase in size of the cyst was observable on roentgenograms taken on August 25 (Fig. 5 *B*).

CASE 6.—C. P. W., a 24-year-old white man, was admitted to a military hospital in August 1944 for swelling and pain in the right ankle and heel, of three months' duration. The history revealed moderately severe trauma on several occasions during the past six years.

Tests of the skin and sputum for coccidiodes were reported as giving negative results.

Examination showed mild generalized tenderness and swelling of the medial and lateral portions of the heel. The roentgenograms were typical of solitary cyst of the os calcis. The values for blood phosphorus and calcium, the sedimentation rate, the Kahn test, a complete blood count and urinalysis were essentially normal (Fig. 6 *A*).

Because of the possibility of fracture of the cyst wall in a young man engaged in vigorous activity, surgical intervention was undertaken.

At operation, clear yellowish fluid was observed in a cyst about 1 by 1.5 cm., with a lateral wall about 1/8 inch (0.3 cm.) thick. The cyst was lined with smooth, sclerotic bone. The cyst area was thoroughly curetted and packed with small cortical grafts previously removed from the right tibia.

The pathologist's diagnosis of biopsy specimens from this cyst was "material from a simple bone cyst." Space does not permit giving the full details of this report. A Gram stain of a smear from this cyst revealed no bacteria.

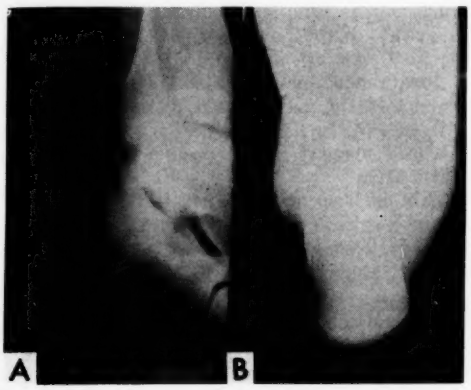

Fig. 6 (Case 6).—Roentgenogram (Sept. 22, 1944), showing solitary cyst of right os calcis.

Fig. 7 (Case 7).—*A*, lateral view showing large rarefied area on anterior aspect of right os calcis, probably penetrating anterior aspect of plantar cortex of os calcis. *B*, roentgenogram taken four and one-half months after operation. Bone graft partially united.

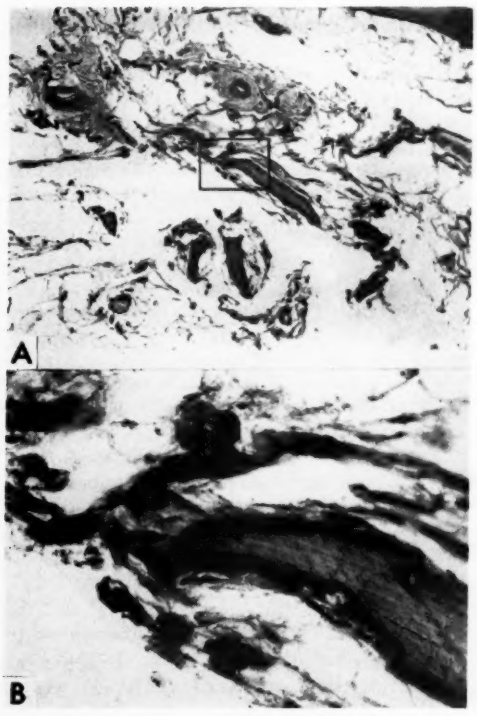

Fig. 8 (Case 7).—*A*, microscopic section of cyst material, low power (× 40). *B*, microscopic section of cyst material, high power (× 300).

In February 1945 the patient was discharged to full military duty, and no further complaints of pain in the foot or ankle have been reported to me.

In this case, part of the pain on weight bearing may have been caused by the cyst, although this was not proved and the complaints were probably due primarily to chronic sprain of the ankle.

As to the operation, a better procedure would probably be deeper curettement of the cyst wall and the use of cancellous bone grafts.

CASE 7.—J. P., a 37-year-old white man, was seen by a colleague on Sept. 8, 1941, for pain and tenderness in the plantar area of the right heel, of three months' duration. The pain was worse on arising in the morning and was decreased by wearing shoes. The history revealed pain in both feet after the patient had jumped

from a burning building and also after he had played football years earlier.

Examination showed tenderness on the plantar surface of the right heel, just anterior to the point of origin of the plantar fascia, but otherwise revealed no abnormality.

Roentgenograms taken on the same day showed a well-defined oval rarefied area in the right os calcis, about 1 by 1¾ inches (2.5 by 4.4 cm.) with "ground glass" appearance (Fig. 7 *A*), possibly invading or penetrating the anterior cortex.

The first impression was that of calcaneobursitis, and the roentgenologist suggested polyostotic fibrous dysplasia. Hyperparathyroidism was considered ruled out by normal levels of blood calcium, phosphorus and alkaline phosphatase.

On September 25 operation was performed, as the cyst was considered the most likely cause of pain in the heel.

The cystic area, containing a soft white material, was thoroughly curetted and filled with a single cancellous iliac bone graft.

Convalescence was uneventful, and walking without difficulty was begun on November 10.

The pathologist's report on microscopic sections of the cystic material (Fig. 8) was as follows: "Sections show bone. The lacunae and lamellae are within normal limits. There is no evidence of excessive osteoclastic reaction. Density is less than average, but the reason for the loss of density is not apparent in the histologic picture. There is no evidence of inflammatory reaction or of pathologic change. The cause of the bone cyst is not explained by the histologic appearance."

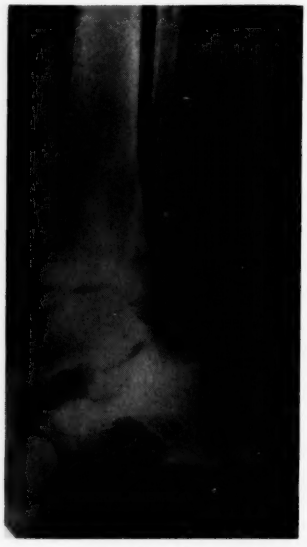

Fig. 9 (Case 8).—Roentgenogram taken April 26, 1948, of right ankle, showing unicameral cyst of os calcis in typical anterior-plantar location.

Roentgenograms taken on Feb. 10, 1942, showed fairly good filling of the cystic area with bone (Fig. 7 *B*). A localized rarefied area was still present in the posterior part of the cystic area.

This is a case in which the plantar heel symptoms were possibly referable to the cyst. The roentgenographic appearance and the results of biopsy were typical.

CASE 8.—D. P., a 21-year-old white man, was seen by a colleague, an orthopedist, on April 26, 1948, for sprain of the right ankle incurred in athletics. The history revealed frequent strains of both ankles. Several normal roentgenograms of the legs and chest had been taken. There was no complaint of pain or tenderness in the heel.

Examination showed moderate swelling and tenderness of the right side of the ankle and the posterior portion of the foot. Pronation of both ankles and flatness of the longitudinal arches were observed.

Roentgenograms taken the same day showed a unicameral cyst of the right os calcis, about ¾ by ⅞ inch (1.9 by 2.1 cm.) in the typical anterior-plantar aspect of the bone (Fig. 9).

Treatment consisted of protection of the ankle. The patient gradually returned to full activity in about six weeks. No symptoms referable to the heel were noted.

This last case shows a fairly large unicameral cyst without definitely referable symptoms, although with a history of repeated trauma to the foot and ankle involved.

SUMMARY

Eight cases of solitary or unicameral cyst of the os calcis are presented, in 4 of which the patients were children. Symptoms possibly referable to the cyst were present in a small percentage of cases. Two patients were treated surgically.

So far as present studies and the literature are concerned, the exact cause of solitary os calcis cyst is apparently unknown. A congenital factor and repeated trauma are suggested as possible causes.

At present no record of fracture into these cysts has been discovered, although it appears reasonable that fractures have occurred and have not been reported. Insurance, as well as military and other liabilities, might be involved in cases of "pathologic" fracture.

The majority of cysts of this type are diagnosed incidentally, from roentgenograms taken for other reasons. Usually there are no symptoms referable to the cyst.

Chemical studies of blood calcium, phosphorus and alkaline phosphatase in this series, when performed, gave essentially normal results.

Biopsy revealed only simple cyst and served essentially to rule out a number of other lesions.

In the case of an adult with a well-defined solitary cyst of the os calcis, there is a fairly definite indication for surgical intervention, although if no symptoms are present the surgeon may question this. For a child, observation until adult bone has developed, is probably the best management.

When operation is performed on an adult, the cyst wall should be very thoroughly curetted and the entire bony cavity packed with cancellous bone chips.

RIASSUNTO

Vengono presentati 8 casi di cisti solitaria o uniloculare del calcagno; 4 di questi malati erano bambini. Solo in una piccola percentuale di casi vi erano sintomi riferibili alla cisti. Di questi malati 2 furono trattati chirurgicamente.

Per quanto se ne sa al momento attuale, la causa precisa della cisti calcaneare è sconosciuta. Si ritengono cause probabili alcuni fattori congeniti e i traumi ripetuti.

Fino ad ora non si sono mai verificate fratture in corrispondenza di tali cisti, benchè sia probabile che di fratture ve ne siano state ma non descritte nella letteratura.

Nella maggioranza dei casi queste cisti vengono scoperte accidentalmente su radiogrammi presi per altre ragioni; di solito non vi sono sintomi significativi.

Il dosaggio della calcemia, del fosforo e dei fosfati alcalini, eseguito nei malati presentati, dimostrò valori normali.

La biopsia dimostrò semplicemente la cisti e servì sopratutto ad escludere lesioni di altra natura.

ZUSAMMENFASSUNG

Es wird über acht Fälle von solitären oder einkammerigen Zysten des Fersenbeins, unter denen sich vier Kinder befanden, berichtet. Nur ein kleiner Prozentsatz der Fälle zeigte Krankheitszeichen, die auf die Zyste zurückgeführt werden konnten. Zwei Patienten wurden chirurgisch behandelt.

Soweit sich aus den vorliegenden Untersuchungen und aus dem Schrifttum feststellen lässt, ist die genaue Ursache der solitären Zyste des Fersenbeins offenbar unbekannt. Als mögliche Ursachen werden angeborene Faktoren und wiederholtes Trauma vorgeschlagen.

Es liegen bisher keine Beobachtungen über in diesen Zysten auftretende Brüche vor, obgleich man wohl annehmen kann, dass Brüche vorgekommen aber nicht berichtet worden sind.

Fragen der Versicherung sowie militärische und andere Pflichten mögen in Fällen sogenannter pathologischer Frakturen eine Rolle spielen.

Die meisten dieser Zysten werden zufällig auf Röntgenaufnahmen entdeckt, die aus anderen Gründen angefertigt wurden. Im allgemeinen bestehen keine Krankheitszeichen, die auf die Zyste zurückgeführt werden können.

Chemische Untersuchungen des Kalziums, Phosphors und der alkalischen

Phosphate im Blut haben, soweit sie in dieser Serie ausgeführt wurden, im wesentlichen normale Befunde ergeben.

Die Probeexzision ergab nur eine gewöhnliche Zyste und diente im wesentlichen nur dazu, eine Reihe anderer Erkrankungen auszuschliessen.

RÉSUMÉ

Huit cas (dont 4 chez des enfants) de kyste solitaire ou unicellulaire du calcaneum sont présentés. Des symptômes probablement en rapport avec le kyste ont été constatés dans un petit pourcentage de cas. Deux malades ont été traités chirurgicalement.

La cause du kyste solitaire du calcaneum semble encore inconnue. Un facteur congénital et des traumatismes répétés pourraient être incriminés. Il parait possible de penser à des fractures dans ces cas bien que ce fait n'ait pas été mentionné.

La majorité des kystes de ce genre sont diagnostiqués incidemment par des radiographies faites pour une autre affection. Habituellement aucun symptôme n'en indique la présence.

Les examens chimiques du calcium sanguin, du phosphore et des phosphates alcalins se sont révélés normaux. La biopsie n'a montré qu'un kyste simple et a servi surtout à éliminer d'autres affections.

SUMARIO

São apresentados oito casos de cistos isolados ou uni-cavitários do calcâneo, quatro dos quais com incidência em crianças. Os sintopropriamente ligados aos cistos foram encontrados em pequena percentagem dos casos. Dois pacientes foram tratados cirúrgicamente. Tanto quanto permitam os estudos atuais e os registros da literatura a exata etiologia dêsses cistos é, aparentemente, desconhecida. São sugeridos como causas um fator congênito e o trauma repetido. Embora considerando possivel a existência de fraturas entre os casos citados nenhuma ocorrência foi meccionada.

As companhias de seguros e os serviços militares assim como organizações similares podem ter assinalado casos de fraturas "patológicas."

A maioria dos cistos do tipo descrito é diagnósticada acidentalmente durante os exames radiográficos por outros motivos. Não há, habitualmente, sintomatologia própria.

Os estudos da bioquímica do calcio, do fósforo e dos fosfatos alcalinos, nesta serie, quando feitos, demostraram normalidade.

A biópsia revelou apenas cisto simples e servio, principalmente, para afastar a hipotese da existência de outras lesões.

RESUMEN

Ocho casos de quiste solitario o unicameral del os calcis son presentados, en cuatro de los cuales los pacientes fueron niños. Posiblemente síntomas referidos al quiste, estuvieron presentes en un pequeño porcentaje de casos.

Dos pacientes fueron tratados quirúrgicamente. Hasta aquí los estudios presentes y la literatura son concernidos, la causa exacta del os calcis del quiste solitario es aparentemente desconocido.

Un factor congénito y trauma repetido son sugeridos como causas posibles.

Hasta la fecha ningún record de fractura entre estos quistes ha sido descubierto, aunque esto parece razonable que fracturas hayan ocurrido y hayan sido reportadas.

Responsabilidades tanto de seguros como militares y otras, pueden estar envueltas en casos de fracturas patológicas.

La mayoría de los quistes son diagnosticados accidentalmente con rayos X tomados por otras razones. Usualmente no hay síntomas referidos al quiste.

Estudios químicos de calcio fósforo y fosfatos alcalinos en sangre en estas series, cuando fueron hechos, dieron resultados esencialmente normales.

La biopsia reveló unicamente quiste simple y sirvió esencialmente para descartar otras lesiones.

BIBLIOGRAPHY

Adams, C. O., and others: Regional Fibrocystic Disease, Surg., Gynec. & Obst. 71:22-32, 1940.

Bick, E. M.: Differential Diagnosis of Solitary Cystic Areas in Bone, J. Mount Sinai Hosp. 8: 1225-1231, 1942.

Coley, B. L., and Sharp, G. S.: Primary Tumors of the Os Calcis: A Study of Thirty-Two Cases with a Review of the Literature, Am. J. Cancer 16:1053-1076, 1932.

Coley, B. L., and Higinbotham, N. L.: Solitary Bone Cyst, the Localized Form of Osteitis Fibrosa Cystica, Ann. Surg. 99:432-448, 1934.

Copleman, B.; Verdoli, M. F., and Crimmings, F. J.: Solitary Cyst of the Calcaneus, Radiology 47:142-148, 1946.

Fett, H. C., and others: Bone Cyst: Regeneration of Bone Following Subperiosteal Resection, Am. J. Surg. 74:886-888, 1947.

Gibson, C. L.: Operation for Epithelioma of the Heel, Ann. Surg. 43:609, 1906.

Horwich, I. D.: Infiltrating Squamous Cell Epidermoid Carcinoma Involving the Os Calcis, Am. J. Surg. 55:166-168. 1942.

Jaffe, H. L., and Lichtenstein, L.: Solitary Unicameral Bone Cyst with Emphasis on Roentgen Picture, Pathologic Picture and Pathogenesis, Arch. Surg. 44:1004-1025, 1942.

James, A. G., and others: Solitary (Unicameral) Bone Cyst, Arch. Surg. 57:137-147, 1948.

Janes, J. M.: Localized Bone Cyst of the Os Calcis, J. Bone and Joint Surg. 28:182, 1946.

McLaughlin, A. D.: Treatment and Results in Localized Osteitis Fibrosa Cystica (The Solitary Bone Cyst), J. Bone and Joint Surg. 25:777-790,

Meyerding, H. W., and others: Progress in Orthopedic Surgery for 1946; a Review Prepared by an Editorial Board of the American Academy of Orthopaedic Surgeons, Arch. Surg. 57:871-896, 1948.

Meyerding, H. W., and Jackson, A. E.: Benign Giant-Cell Tumors: A Report of 7 Cases in Which the Bones of the Hands and Feet Were Involved, Surg. Clin. North America 30:1201-1213, 1950.

Miltner, L. J., and Wan, F. E.: Giant-Cell Tumor of the Os Calcis: Report of a Case Treated by Resection and Tendon Transplantation, J. Bone & Joint Surg. 14:406-409, 1932.

Moore, J. R.: Tumors of the Os Calcis, Radiology 16:232-244, 1931.

Pommer, G.: Zur Kemtnis der progressiven Hamatom-und Phlegmasie-veranderungen der Rohrenknochen, Arch. F. orthop. u. Unfall-Chir. 17:17, 1920.

Schreiner, B. F., and Wehr, W. H.: Primary Malignant Tumors of the Foot, Radiology 21:513, 1933.

Stewart, M. J., and Hamel, H. A.: Solitary Bone Cyst, South. M. J. 43:927-936, 1950.

Verstandig, C. C.: Solitary Unicameral Cyst of the Os Calcis: Report of a Case, New England J. Med. 237:21-22, 1947.

Von Mikulicz, J.: Ueber cystische Degeneration der Knoches, Verhandl. d. Gesellsch. deutsch. Naturforsch. u. Azerzte 76:107, 1906.

I please myself with thinking that the method of teaching the art of healing is becoming every day more conformable to what reason and nature require; that the errors introduced by superstition and false philosophy are gradually retreating; and that medical knowledge, as well as all other dependent upon observation and experience, is continually increasing in the world. The present race of physicians are possessed of several most important rules of practice, utterly unknown to the ablest in former ages, not excepting Hippocrates himself, or even Aesculapius.

—*Heberden*

Surgical Treatment of Hydatid Cysts of the Lung in Two Hundred Cases

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IN the lung the hydatid cyst is nearly always unilocular, with liquid contents, and the [parasitic] membrane is surrounded by an adventitial layer. This is a fibroconnective lamina related to the lung, which has thus reacted to the growth of the cyst. This description applies to the pure and noninfected hydatid cyst. When the cyst has reached a large size it generally opens into a bronchus, and hydatid vomica or hydatidoptysis occurs. Rupture of the cyst in the pleura is less frequent (hydatidopleura). At any rate, in either case it becomes infected.

Symptoms. — The main symptoms are those of a bronchopulmonary suppurative condition. The presence of complicated cysts with a prolonged clinical course, other pulmonary lesions, such as bronchiectasis or pleuritis, appear.

Treatment. — Surgical treatment varies according to the number, size and clinical course of the cysts and according to the presence or absence of complications.

The parasite and the host must both be taken into account; in other words, removal of the larvae or cysts and treatment of associated pulmonary lesions, if any, will be required, with prophylactic measures directed toward the residual pulmonary cavities.

Read at the Twenty-First Annual Congress of the United States and Canadian Sections, International College of Surgeons, Chicago, Sept. 9-13, 1956.

Submitted for publication Sept. 21, 1956.

Material and Methods.—In the Institute of Thoracic Surgery of Buenos Aires, 273 cysts in 200 patients have been treated in 224 operations (Table 1).

TABLE 1.—*Surgical Treatment of Hydatid Cysts*

Patients	200
Operations	224
Cysts	273
Noninfected	148
Infected	125

Hydatid cysts with a presumptive or confirmed diagnosis were operated upon, with the patient under general anesthesia, in a closed circuit after laryngotracheal intubation with cyclopropane-ether-oxygen. Induction was obtained with intravenous pentothal sodium. In some cases curare was injected and cyclopropane replaced by nitrous oxide.

TABLE 2.—*Data on Two Hundred and Twenty-Four Operations*

Pulmonary Resections		93 (41.5%
Pneumonectomy	4	
Lobectomy	37	
Partial resection	52	
Other Procedures		131 (58.5%
Marsupialization	81	
Posadas operation	45	
Drainage	5	

A wide posterolateral thoracotomy with resection of the posterior fragment of two or three ribs permits one to perform a sufficiently comfortable pleurotomy exploration of the lung and to perform the most suitable operation.

Cystostomy or pneumocystostomy and evacuation of the parasite are usually preliminary measures.

A decision is reached in favor of (1) bronchial suture, (2) closing of the adventitia, (3) marsupialization in the most suitable spot or (4) pulmonary resection. The type and extent of the operation will be determined by the size of irreversible lesions or by technical needs in the particular case.

Technic varies according to circumstances, but it always consists of dissection and individualization of the vasculobronchial elements of the pedicles and hermetic bronchial suture protected by soft neighboring tissue or by the pleura.

Mobilization of the lobes with firm vascularized adhesions to the thoracic wall, particularly those subjected to a former marsupialization, is performed as a last recourse after control of the pedicle.

This plan suppresses the blood flow into the lobe, diminishes hemorrhage from dissection of the adhesions and excludes the bronchocavitary system.

Temporary pleural drainage connected to an irreversible or gentle aspirating system helps in re-expansion of the lobes and evacuation of transudates.

Dissection of the remaining lobes is conditioned by the technical demands of the resection and the need of allowing sufficient expansion. Hence it is unwise to sever the superior connection of the lobe with the thoracic apex; on the other hand, it is useful to cut the pulmonary ligament to facilitate displacement of the inferior lobe.

Antibiotics, given parenterally or orally before and after the operation, are also inserted into the pleural cavity at the end of the surgical procedure. A bronchoscopic procedure is done either during ablation or at the end of it, according to circumstances.

Obstruction of the bronchi by particles of parasitic membrane, pus or blood calls for careful attention to the permeability of the bronchial tree and immediate endobronchial aspiration.

Catheters of the Magill, the Crafoord or the Björk-Carlens type are useful for blocking off the diseased section from the beginning of the anesthesia. I have also employed Guebauer's catheter, with equally satisfactory results.

Extensive thoracotomy offers the advantage of treating several pulmonary cysts or pulmonary and hepatic cysts in a single operation.

The *immediate benefits* obtained when hydatid cysts are treated by resection rather than by any other surgical procedure are (1) a shorter period of warding, (2) healing of the operative wound (*per primam* and (3) fewer and less serious complications. The *lasting benefits* obtained are (1) improved functional thoracic readjustment, (2) absence of residual pulmonary cavities and (3) lack of symptoms due to residual cavities, bronchiectasis, etc.

Theoretically, hydatid cysts of the lung are generally peripheral; yet the presence of cysts surrounded by pulmonary parenchyma calls for reflection with regard to the truth of this statement. It is possible that the hydatid cyst is peripheral to the segment in which it originally developed, but segmentary apposition in the structure of the lobes might explain its location deep in the organ.

Surgical intervention for hydatid cysts of the lung should be performed in well-equipped centers by experienced surgeons. This is indispensable to surgical, biologic and functional success.

In surgical treatment, three objectives must be kept in mind: liberation from echinococcosis, healing of the affected organ and functional recovery.

Surgical treatment as established by Posadas (closure without drainage), with any of its modifications, or pulmonary resection (atypical, segmentary or lobular) may be indicated.

Rupture of the cyst into the pleura permits evacuation of the parasite partially or totally lodged in the lung or in the pleura (Table 5).

Surgical decortication achieves pulmonary re-expansion and occlusion of the pleural cavity. The technic must be adjusted to the treatment of empyema or hydropneumothorax due to pulmonary perforation.

All lesions caused by chronic bronchoalveolitis, bronchiectasis or secondary sclerosis are important in the area near chronically infected hydatid cysts. The irreversible nature of these lesions justifies pulmonary resection.

This operation was performed in 55 cases of noninfected and 53 cases of infected cysts. Three deaths occurred in 93 resections.

Marsupialization or drainage was employed in 30 cases of noninfected and 52 cases of infected cysts. One death was recorded among the 81 operations performed by this method.

Posadas' operation was performed in 58 cases of noninfected and 16 cases of infected cysts. One death was recorded in the 45 operations.

Pleural drainage was carried out in 9 cases.

As a result, of 224 interventions for treatment of 273 cysts, a primary mortality rate of 2.7 per cent (6 deaths) was recorded.

For partial resection various surgical procedures were employed, each of which should be considered separately.

TABLE 3.—*Surgical Treatment of Two Hundred and Seventy-Three Cysts*

	Total	*Non-infected*	*Infected*	*Operations*	*Deaths*
Pulmonary resection	108	55	53	93	3
Marsupialization	82	30	52	81	1
Posadas' operation	74	58	16	45	1
Drainage	9	5	4	5	1
	273	148	125	224	6

TABLE 4.—*Pulmonary Resections (93 Operations; 108 Cysts)*

	Noninfected	*Infected*	*Deaths*
Partial resection (segmentary-wedge-shaped)	42	17	..
Lobectomy	10	33	2*
Pneumonectomy	3	3	1*
	55	53	3 (2.8%)

*Infected.

TABLE 5.—*Hydatid Cysts of the Lung Opening into the Pleural Cavity (11 Patients)*

Pleural Drainage	OPERATION THORACOTOMY				*Thoracoplasty*	*Deaths*
	Marsupialization	*Decortication*	*Posadas' Operation*	*Pulmonary Resection*		
+	+	—	—	—	—	—
+	+	—	—	—	+	—
+	+	—	—	—	—	—
+	+	+	—	—	—	—
+	+	—	—	—	—	—
+	—	—	+	—	—	—
+	+	—	—	—	—	—
+	—	+	—	+	+	—
—	—	—	—	+	—	+
+	+	+	—	—	—	—
+	—	—	—	+	—	—

Segmentary pulmonary resection, whether wedge-shaped or atypical, was performed in 52 cases. The open edges resulting from the partial pulmonary resection were brought together by interrupted stitches of absorbable material.

Lobectomy was performed in 43 cases and pneumonectomy in 6.

In the series of *noninfected cysts*, lobectomy or pneumonectomy was reserved for multiple cysts or for cysts occupying an entire lobe or lung.

Marsupialization was preferred for large cysts, particularly those located in the inferior lobes.

Only 1 death was registered among the 148 cases of noninfected cysts, but in this case the condition was bilateral.

In the series of *infected cysts*, differentiation should be made between cases in which intrabronchial rupture had occurred and those in which intrapleural communication was present. The latter type was associated with extremely serious complications that urgently require pleural drainage. In the last case a pulmonary decorti-

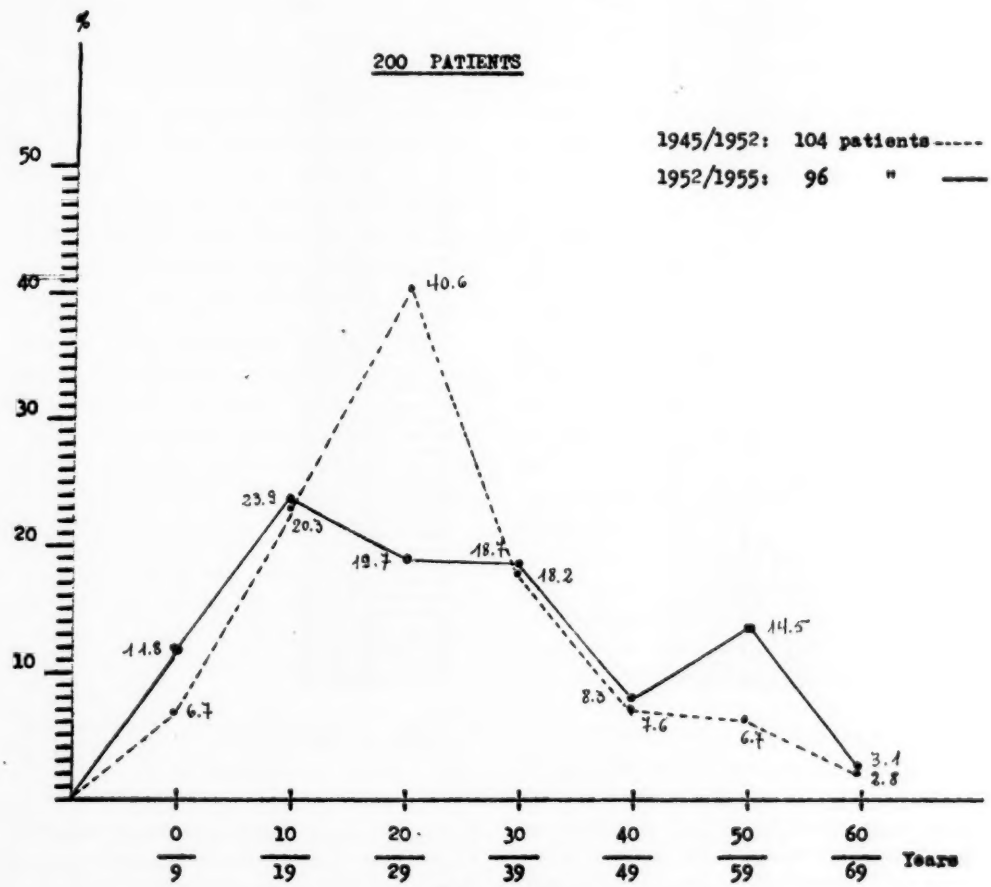

Fig. 1 (see text).

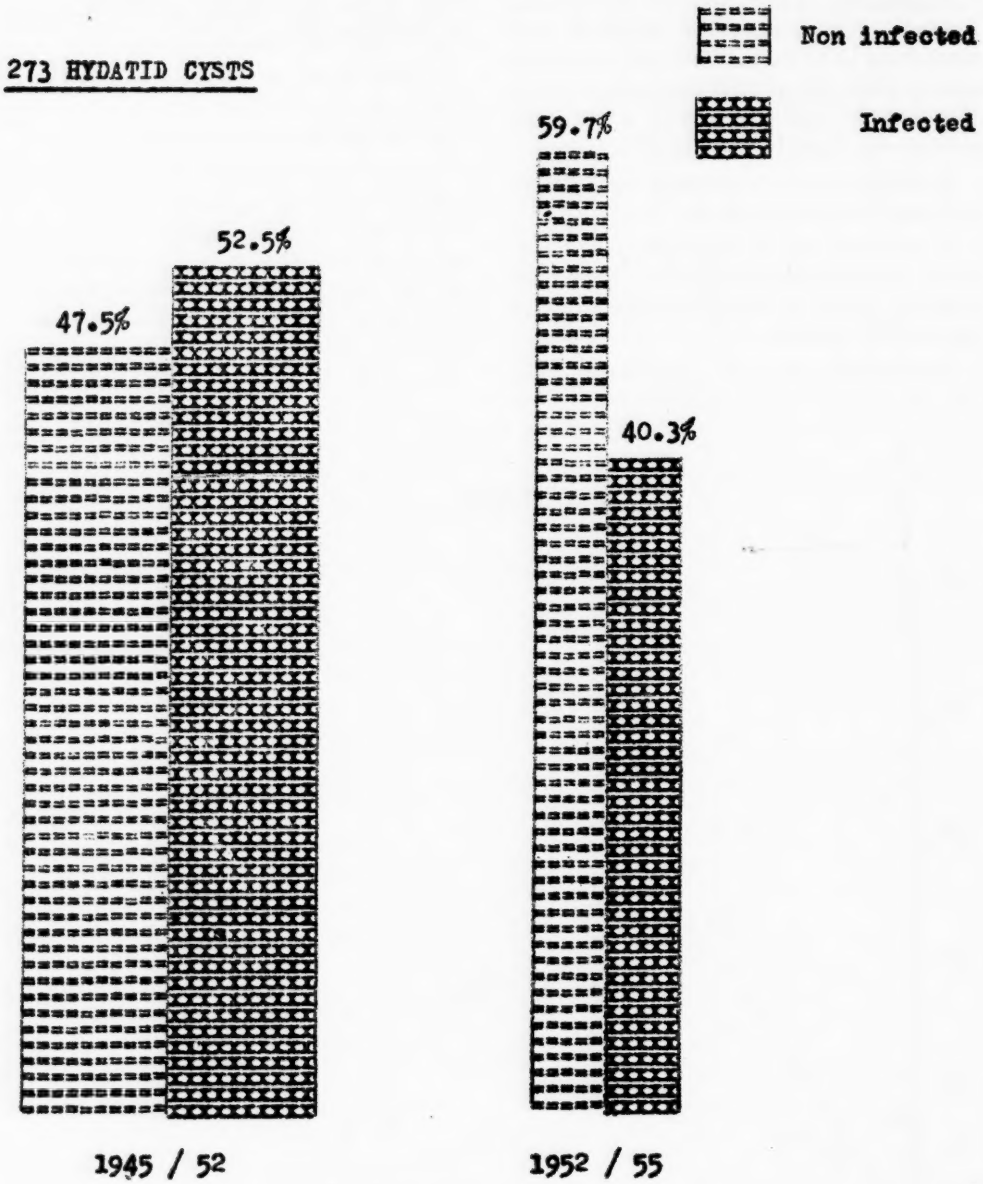

Fig. 2 (see text).

cation was performed, with drainage of the adventitial cavity; the results were excellent. In the oldest patient, secondary pleural echinococcosis eventually developed, and four more operations were required; one thoracophrenolaparotomy and three thoracotomies with marsupialization of the cysts.

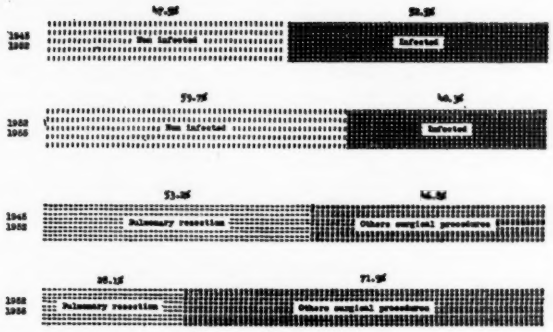

Fig. 3 (see text).

Intrabronchial rupture offers varied symptoms, with different degrees of infection and hazard.

In 3 cases drainage evacuated a large quantity of hydatid cysts due to persistent or relapsing echinococcosis. One of the patients died from hemorrhage; the others recovered.

In the series of infected cysts, and particularly among those complicated by intrabronchial rupture, pulmonary resection was the predominant treatment.

Partial resection was the type most frequently used; pneumonectomy was performed on a lung in which a hydatid cyst and a tuberculoma were present.

Marsupialization was performed in cases of infected cysts, when either the general condition or the technical difficulties indicated that pulmonary resection was inadvisable.

Posadas' operation was employed for small but complicated cysts, or in cases in which their localization would have proved dangerous.

TABLE 6.—*Deaths (6 Cases)*

Drainage	1
Marsupialization (bilateral cysts)	1
Partial resection	1
Lobectomy	2
Pneumonectomy (multiple cysts)	1
273 cysts 2.2%	
224 operations 2.7%	
200 patients 3.0%	

Five deaths were registered in the 125 cases of infected cysts. One occurred in a case of recurrent echinococcosis following drainage in the area of a previous marsupialization. Death was caused by postoperative pulmonary hemorrhage.

Two deaths occurred after lobectomy, 1 due to "lower nephrosis" and the other to intracystic hemorrhage and bronchial flooding during the operation.

The treatment of choice for 273 cysts was evacuation of the parasite and pulmonary resection. For the latter different technics were employed, ranging from partial atypical resection to total pneumonectomy.

Mortality was limited to 6 cases (2.7 per cent).

Surgical Treatment of Children from 4 to 15 years of age offered certain special characteristics. Our experience extends to 35 patients who underwent 46 operations for treatment of 57 cysts (Table 7).

Pulmonary resection was performed for 14 cysts, lobectomy being done in 5 cases for six cysts. Partial resection was done in 9 cases with 9 cysts.

Lobectomy, technically rather easy to perform on a child, is recommended for infected cysts or noninfected but large cysts covering nearly the entire lobe. In

TABLE 7.—*Children Under 15 Years of Age*

	Patients	35		
	Operations	45		
	Cysts	54		
			Noninfected	*Infected*
With pulmonary resection 14	Lobectomy	5	2	4
	Partial resection	9	8	1
Without pulmonary resection 42	Marsupialization	14	7	8
	Posadas' operation	26	19	7
	Pulmonary decortication + Marsupialization	1	....	1

other cases we prefer partial resection or other procedures (Posadas', marsupialization, etc.), considering the easy anatomic and functional recovery of children's lungs and hence the undesirability of serious surgical mutilation.

Surgical treatment without pulmonary resection was employed in the treatment of 42 cysts. In 15 cases marsupialization was carried out; in 26 Posadas' operation was performed, and in 1 case of cystic rupture into the pleural cavity marsupialization of the adventitia and pulmonary decortication were performed.

Evacuation of the parasite in cases of extremely large cysts, occupying nearly the entire lobe, was followed by reexpansion of a considerable area of lung.

The adventitial cavity was seen to disappear with surprising rapidity.

Multiple Pulmonary Echinococcosis. — In 41 of 200 cases, echinococcosis proved to be multiple. Localization was bilateral in 16 cases and unilateral in 25 (Table 8).

TABLE 8.—*Multiple Pulmonary Echinococcosis*

Unilateral Cysts		25
Right side	12	
Left side	13	
Bilateral Cysts		16

TABLE 9.—*Data on Two Hundred and Seventy-Three Hydatid Cysts*

	1945/1952: 124 Cysts		*1952/1955: 148 Cysts*	
Noninfected	59	47.5%	89	59.7%
Infected	65	52.5%	60	40.3%
Pulmonary resection	66	53.2%	42	28.1%
Other procedures	28	46.8%	107	71.9%
Marsupialization	39		43	
Posadas' operation	15		59	
Drainage	4		5	

COMMENT

Since 1952, patients undergoing operation are younger than those formerly operated on (Fig. 1). In addition, the average incidence of noninfected cysts is higher than before 1952 (Fig. 2). This is the result of (1) improved training of doctors and the public in sanitation; (2) mass roentgen examinations of the thorax, and (3) improved surgical treatment.

According to these data, pulmonary resection is performed less frequently than it was some years ago (Table 9 and Fig. 2).

SUMMARY

A brief résumé of the diagnosis and surgical treatment of hydatid cyst of the lung is presented.

The authors analyze the experience obtained at the Institute of Thoracic Surgery (Buenos Aires) in the treatment of 200 cases of hydatid cyst, in which 93 pulmonary resections, 81 marsupializations, 45 Posadas operations and 5 other procedures were done, according to the pathologic configuration of the cysts and conditions of the lungs.

The importance of pneumonitis and bronchiectasis secondary to chronic infected cysts is pointed out.

RESUMEN

Un breve resumen del diagnóstico y tratamiento quirúrgicos del quiste hidatídico del pulmón se presenta.

Los autores analizan la experiencia obtenida en el Instituto de Cirugía Torácica (Buenos Aires) en el tratamiento de 200 casos de quiste hidatídico en los cuales 93 resecciones pulmonares, 81 marsupializaciones, 45 operaciones de Posadas y 5 otros procedimientos fueron hechos, según la configuración patológica de los quistes y condiciones del pulmón.

RIASSUNTO

Viene presentato un breve studio sulla diagnosi e sulla cura chirurgica dell'idatidosi polmonare.

Viene riferita l'esperienza ottenuta all'Istituto di Chirurgia Toracica di Buenos Aires nella cura di 200 casi di echinococcosi polmonare: si fecero 93 resezioni del polmone, 81 marsupializzazioni, 45 operazioni di Posadas e 5 altri interventi, in rapporto alle caratteristiche anatomiche della cisti e a quelle del polmone.

SUMARIO

Apresenta um breve resumo do diagnóstico e tratamento cirúrgico do cisto hidático do pulmão. O A. analiza a experiência colhida no Instituto de Cirurgia Torácica (Buenos Aires) pelo tratamento de 200 casos de cisto hidático, nos quais, executou, 93 resecções pulmonares, 81 marsupializações, 45 operações de Posadas alem de 5 outros métodos, tudo de acordo com os aspectos patológicos dos cistos e com as condições pulmonares dos pacientes.

ZUSAMMENFASSUNG

Es wird ein kurzer Überblick über die Diagnose und die chirurgische Behandlung der Echinokokkuszyste der Lunge gegeben.

Die Verfasser erläutern ihre im Institut für Thoraxchirurgie (Buenos Aires) mit der Behandlung von 200 Fällen von Echinokokkuszysten gewonnenen Erfahrungen. Je nach der pathologischen Gestalt der Zysten und nach dem Zustand der Lunge wurden 93 Lungenresektionen, 81 Zysteneinnähungen, 45 Posadasche Operationen und 5 andere Eingriffe ausgeführt.

RÉSUMÉ

Un bref résumé du diagnostic et du traitement chirurgical du kyste hydatique du poumon est présenté.

L'auteur analyse les résultats obtenus à l'Institut de chirurgie thoracique de Buenos Aires, dans le traitement de 200 cas de kyste hydatique (avec 93 résections pulmonaires, 81 marsupialisations, 45 opérations de Posadas, et 5 autres techniques), selon les caractéristiques pathologiques des kystes et l'état pulmonaire.

BIBLIOGRAPHY

(Trabajos del autor y sus colaboradores sobre hidatidosis)

Taiana, J. A., y Orsi, A.: Quiste hidatídico del pulmón y vacunación pleural. Bol. del Inst. de Cl. Quirúrg. 18:89, 1941.

Taiana, J. A.; Perez, B., y Boragina, R. C.: Equinococosis pulmonar. Cavidades residuales visualizadas por broncografía. Bol. del Inst. de Cl. Quirúrg. 19:545, 1943.

Taiana, J. A.; Orsi, A., y Spirito, E.: Hidátidopleura. Pioneumotórax consecutivo a la rotura traumática de un quiste hidatídico del pulmón.

Bol. del Inst. de Cl. Quirúrg. 19:620, 1943; Bol. y Trab. Acad. Argent. Cirug. 27:669, 1943.

Ivanissevich, O., y Taiana, J. A.: Falsas recidivas de los quistes hidatídicos del pulmón. Bol. y Trab. Acad. Argent. Cirug. 28:48, 1944.

Taiana, J. A.: Ensayo histórico sobre el tratamiento quirúrgico de la equinococosis en la República Argentina (Trabajo de adscripción a Clínica Quirúrgica, presentado a la Cátedra de Historia de la Medicina, 1943). Bol. del Inst. de Cl. Quirúrg. 20:529, 1944; Arch. de Tisiol. 21: 336, 1946.

Taiana, J. A.; Schieppati, E., y Boragina, R. C.: Equinococosis pulmonar. Tratamiento quirúrgico. Rev. de la A.M.A. 62:441,1948.

Taiana, J. A.; Fernandez Luna, D.; Boragina, R. C., y Leva, A.: Interpretación anatomopatológica y radiológica de la equinococosis pulmonar. Arch, Intern. de la Hidatidosis. 8:100, 1948. Azul, Bs. As.

Schieppati, E., y Vollenweider, E. R.: Tratamiento quirúrgico de la hidatidosis pulmonar. Primeras Jornadas Argentinas de Cirugía Torácica, 1948. Editor El Ateneo, Bs. As., 1949.

Taiana, J. A.; Aracama Zorraquin, V. A., y Vollenweider, E. R.: Equinococosis pulmonar. Complicaciones y secuelas. Arch. Int. de la Hisdatidosis. 8:256, 1948.

Gómez García, R. E.: Tuberculoma pulmonar y quiste hidatídico del pulmón. Rev. de la Soc. Argent. de Cirugía Torácica. 1:88, 1949.

Aracama Zorraquin, V. A.: Quiste hidatídico del pulmón derecho. Rev. de la Soc. Argent. de Cirugía Torácica. 1:205, 1949.

Taiana, J. A.: Quistes hidatídicos del pulmón. Cirugía, Ginecología y Urología. 1:253, 1950. Madrid, España.

—Quistes hidatídicos del pulmón. Clínica del Tórax. 3:93, 1959. Bs. As.

—Cisti da echinococco del polmone. La Chirurgia Toracica. 4:249, 1951, Roma. Italia.

—Kystes hydatiques du poumon. Lyon Chirurgical. 46:785, 1951, Lyon, Francia.

Taiana, J. A.; Schieppati, E.; Boragina, R. C., y Aracama Zorraquin, V. A.: Nuestra experiencia en el tratamiento quirúrgico de 124 quistes hidatídicos del pulmón. Bol. y Trab. Soc. Arg. de Ciruj. 13:279, 1952.

—Equinococosis pulmonar. Tratamiento quirúrgico. 124 quistes hidatídicos. El Día Médico, 25: 1282, 1953.

Taiana, J. A.; Schieppati, E.; Aracama Zorraquin, V. A., y Boragina, R. C.: Equinococosis pulmonar múltiple. Ocho observaciones. Tratamiento quirúrgico. Rev. Soc. Arg. Cirug. Torácica, 3:64, 1953.

Taiana, J. A.; Schieppati, E., y Aracama Zorraquin, V. A.: Pulmonary Echinococcosis. Diseases of the Chest, 26:686, 1954.

Taiana, J. A.; Schieppati, E., y Aracama Zorraquin, V. A.: Equinococosis pulmonar. Tratamiento Quirúrgico en 212 quistes. Vol. 2o Congreso Argent. Cirug. Torácica 1954:331, 1955. Rev. Fac. C. Méd. Bs. As. 2:1, 1955.

Taiana, J. A.; Schieppati, E., y Villegas, A. H.: Equinococosis torácica de infrecuente localización. Arch. Int. de la Hidat., Montevideo, Uruguay. 14: 1954. Clínica del Tórax, 7:47, 1955.

Taiana, J. A.: Comentario sobre la publicación de un trabajo inédito de Alejandro Posadas sobre: Tratamiento de los quistes hidatídicos. Clínica del Tórax, 7:1, 1955.

Correction: We regret to state that in the article "Congenital Absence of the Gallbladder in Man," which appeared on Pages 279 to 282 in the September issue of the Journal, the name of the author, Dr. N. N. Iovetz-Tereshchenko, was misspelled. Dr. Iovetz-Tereshchenko also writes us that the word "listed" in the first paragraph of the article should be "stated" and that the sentence "Routine appendectomy was done" should have appeared in the case report on Page 280.

A Comparative Study of Media Used in Bronchography

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BRONCHOGRAPHY is a valuable diagnostic tool in bronchial and pulmonary disease and has been used extensively for over thirty years. By instilling various media into the tracheobronchial tree, bronchial mapping can be accomplished effectively, with extremely low morbidity and mortality rates. Many contrast media are available, which suggests that no single material is satisfactory in every respect. This report is an evaluation of three media commonly used: lipiodol, aqueous dionosil and oily dionosil.

Historic Development.—Many physiologists of the nineteenth century were impressed with the extraordinary absorptive powers of the lungs. They showed that iodides, strychnine and a host of other drugs would be readily absorbed after their introduction into the lungs via the trachea. Potassium iodide, for example, would appear in the urine within five minutes after its introduction into the lungs. Colin,[1] in 1873, showed that 6 liters of water could be introduced into the lungs of a horse without any noticeable discomfort to the animal.

The clinicians were quick to utilize this route as a means of administering drugs. It seemed especially useful in the treatment of patients with pulmonary diseases, since drugs would thereby be placed in direct contact with the diseased organ. Horace Green,[2] in 1855, reported the use of intratracheal silver nitrate in patients with pulmonary tuberculosis.

Various vehicles were tried that would carry the medications to the lungs. It was discovered that certain oils containing the oleic group combined readily with the halogens. The concept of using a combination of oil and drugs—e. g., oil and iodine—in therapy was empiric, but as both these drugs were reputed to be beneficial, the combined effect was anticipated to be even better. Thus, in 1898, Winternitz[3] reported the use of poppy seed oil and iodine in combination for intratracheal therapy.

The increasing use of the roentgen ray, which showed the iodized oils to be radiopaque, prompted the desire to map the bronchial tree. Accordingly, in 1922, Sicard and Forestier[4] described technics for roentgen exploration of the tracheobronchial tree with the iodized oil lipiodol, which is used today in essentially the same form.

As early as 1918, Jackson[5] had reported the use of powdered bismuth subnitrate in localizing foreign bodies in the bronchi. The radiopaque powder was sprayed through a bronchoscope into the segments and subsegments of the lung in order to pinpoint the foreign body on roentgenograms. This procedure greatly simplified the subsequent extraction of the foreign body.

Bronchographic study is now recommended for a variety of conditions. Its value in the diagnosis and localization of nontuberculous bronchiectasis has been well established. Knowledge of the bronchial configuration is of the utmost impor-

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tance in resectional therapy for tuberculosis of the lung, as demonstration of bronchiectatic segments is most helpful to the surgeon.[6] Likewise, its use has been recommended to rule out significant endobronchial lesions in the selection of cases for permanent collapse therapy.[7] Some perform bronchographic studies preoperatively and postoperatively with all thoracoplasties, as a means of evaluating this therapy.[8] Early neoplastic disease or other obstructing lesions may be revealed bronchographically when all other diagnostic efforts have failed.[9] In fact, the bronchographic procedure is now utilized without hesitation when any diagnostic problem involving the lungs is encountered.

The intratracheal instillation of drugs as practiced in the nineteenth century on an empiric basis has thus become a reliable, reasonably safe and fundamental tool in the evaluation of a host of diagnostic and therapeutic problems related to the lung.

Complications. — The warning that bronchographic investigation might be followed by complications came early after the introduction of lipiodol in 1922.[10] Many reports have suggested that lipiodol, which is 40 per cent iodine in poppy seed oil, is capable of producing serious pulmonary and systemic complications. Acute iodism,[11] acute massive collapse of the lung,[12] spread of tuberculous disease,[10] postoperative atelectasis[13] and fatalities[14] have been recorded. The Council on Pharmacy and Chemistry of the American Medical Association in 1932 cautioned that lipiodol should not be used when darkened and that intratracheal injections should be avoided in the presence of tuberculosis of the respiratory organs.[15] Proliferation of the bronchial epithelium,[16] tissue fibrosis[17] and the formation of granulomas[18] have been described as occurring in human patients and in experimental animals.

In contradistinction, many series of bronchograms with lipiodol have been done without serious complications and without fatalities.[19] Experiments in animals have failed to show marked histologic changes in the lungs of the animals after they were killed.[19b] Several series have shown it to be safe for the tuberculous patient. Park[20] has prevented iodism in bronchographic studies with lipiodol by using ACTH. Theodos[21] has shown that the iodine-sensitive patient can be desensitized with ACTH before bronchographic studies are undertaken.

All these reports, though contradictory in many respects, have indicated a need for a medium free from the potentiality of serious complications and prolonged alveolar retention.

Lipiodol is the only medium, so far as we know, that has been studied for changes in pulmonary function following bronchographic procedures. Zavod[22] showed that 90 per cent of the 50 patients he studied showed a decrease in pulmonary volume one hour after the bronchograms had been taken. The highest loss occurred in the respiratory reserve. Daily spirometric measurements showed that the loss of function is recovered gradually over a period of five days to the pre-bronchogram level. It is possible that this phenomenon may occur with all media, whether they are oily, water-soluble, or of the newer suspension type.

Lipiodol has the disadvantage of making serial roentgenograms difficult to interpret in some instances, because the "contrast medium infiltrate" may be retained in the alveoli for long periods. The recent combination of sulfonamides with lipiodol[23] appears to serve the dual purpose of increasing the sharpness of contrast and reducing the period of retention of the dye. Undoubtedly the most consistent objection to lipiodol has been its persistent visibility on thoracic roentgenograms long after its instillation, which tends to obscure the de-

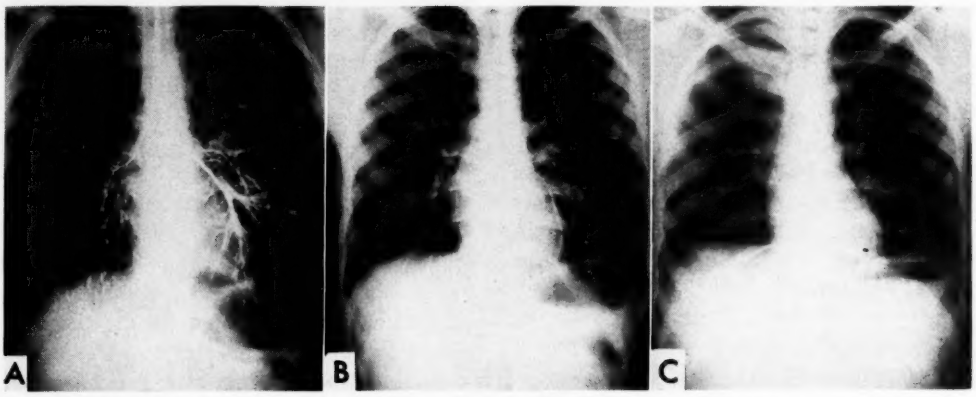

Fig. 1.—*A*, bronchogram of T. G., a 20-year-old man with a tuberculous fibrocaseous residual under the right clavicle. Aqueous dionosil in right bronchi and lipiodol in left. Peripheral filling to terminal bronchi is somewhat better with aqueous dionosil, which tends to coat bronchi rather than pool in them. *B*, film taken two hours later, showing clearing of the media but with alveolar filling in left lung by lipiodol. *C*, six weeks after segmental resection of right upper lobe. "Contrast medium infiltrate" of lipiodol in left lung could readily be confused with contralateral spread of tuberculosis.

tails of any progressive lesion.

The search for a new type of contrast material led to the development of water-soluble media that are rapidly absorbed after intratracheal instillation. Morales and Heiwinkel,[24] in 1948, used 35 per cent diotrast in 2.5 per cent carboxymethylcellulose as the first of such media. Subsequently, Atwell[25] performed bronchographic studies with this preparation, encountering no serious reactions.

Several other water-soluble compounds became available, some of which had iodo pyracet (diodrast) as the contrast medium. Others used urokon in the same manner. The vehicle common to all these media is some form of methylcellulose, a synthetic carbohydrate of high molecular weight. The viscosity of the medium used may be altered by adding varying amounts of the carbohydrate. When the contrast material is of sufficient concentration to produce sharp contrast and the medium is at a desirable viscosity, however, it is hypertonic. Clinically, the water-soluble media have proved irritating, owing to this hypertonicity,[26] which makes satisfactory anesthesia difficult to achieve.

Some studies have shown methylcellulose to be nontoxic to tissues.[27] Other reports[28] indicate that a cellulose synthetic, though nontoxic, acts as a foreign body in the alveoli and bronchi, causing foreign body granulomas and fibrosis. Even small masses could be observed in surgical specimens. Although this perhaps has no great significance in the relatively normal lung, it may be quite deleterious to the already damaged lung.

Although initial studies were promising, in 1953 Peck[29] reported 2 sudden deaths after the use of these water-soluble compounds. One patient, who had been tested for sensitivity, died after bronchographic examination with the diodrast preparation. The other death occurred during the use of urokon in methylcellulose. The patient in this case had not been tested for sensitivity in advance.

During 1953, Tomich, Basil and Davis[30] of England investigated the behavior of a third type of bronchographic medium. This was a suspension, either aqueous or oily, of the n-propyl ester of 3:5- DI-IODI

pyridone acetic acid in methylcellulose or in peanut oil. The two combinations are now known as aqueous and oily dionosil. Their iodine content is 30 per cent and 34 per cent respectively. Aqueous dionosil differs from earlier water-soluble media in that it is an ester of low solubility in water. The suspension yields opacity equivalent to that obtained with diodrast preparations; yet it is isotonic with body fluids, so that no osmotic disturbance is caused. Elimination of dionosil from the lungs occurs within five days.[30] Animal experiments with radioactive iodine (I^{131}), labeled propyliodine, and human metabolism studies showed that the compound is completely hydrolyzed and eliminated through the kidney without breakdown of iodines or iodides. Histologic examinations of lungs excised after bronchographic studies with the dionosils have shown no serious tissue reactions.[31] Dionosil has been shown to have no adverse effect upon the tuberculous patient.[32] The most serious reported complication following the taking of dionosil bronchograms is the occurrence of mild pyrexia, occasionally accompanied by mild malaise and arthralgia. This reaction subsides spontaneously within forty-eight hours without treatment.

Present Study and Technic.—The present study is based on a review of 75 consecutive bronchograms taken with the use of lipiodol, aqueous dionosil and oily dionosil. Twenty-five consecutive bronchograms were taken with each medium. In addition, bronchograms were taken with the use of different media for the two sides. The subjects were inpatients and outpatients of the Mississippi State Sanatorium and were not selected in any way for this study.

Each patient was fasting in order to diminish nausea and the possibility of aspirating vomitus. We employ atropine, a relatively short-acting barbiturate such as pentobarbital, an opiate such as meperidine, and an antihistaminic in appropriate doses forty-five minutes before the beginning of the procedure. The oral pharynx and larynx are anesthetized with a spray of 0.5 per cent pontocaine. Using a laryngeal mirror and cannula, one then injects 0.5 per cent pontocaine in 1 cc. doses directly into the trachea until adequate anesthesia has been achieved.

Usually our initial step in evaluating the tracheobronchial tree is bronchoscopic examination. This, as recommended by Clerf,[33] affords the special advantage that a combination of diagnostic procedures is done at the same time. If bronchograms are still indicated after the bronchoscopic examination, a catheter is inserted through the bronchoscope and placed in the right main stem bronchus. If bilateral bronchograms are to be taken, the right side is always visualized first in order to obtain unobscured views of the right middle lobe, which can be seen adequately only with a lateral film. The contrast medium is then injected through the catheter, under fluoroscopic guidance, into the right side. The segments are filled by positioning the patient so that all bronchi become dependent *seriatim*. A series of roentgenograms, including the posteroanterior, the right lateral, and the right oblique view, is then taken. If the left bronchial system is to be studied and the patient has tolerated the procedure thus far, the catheter is manipulated into the lower portion of the trachea or, preferably, into the left main stem bronchus. Additional medium is then injected and, after adequate posturing, a second series of roentgenograms is obtained, including posteroanterior and left oblique views. If only the left side is studied, a left lateral film is usually obtained in addition.

In our experience, postural drainage has been of great aid in eliminating much contrast material from the bronchi. Bronchodilating drugs also seem highly valu-

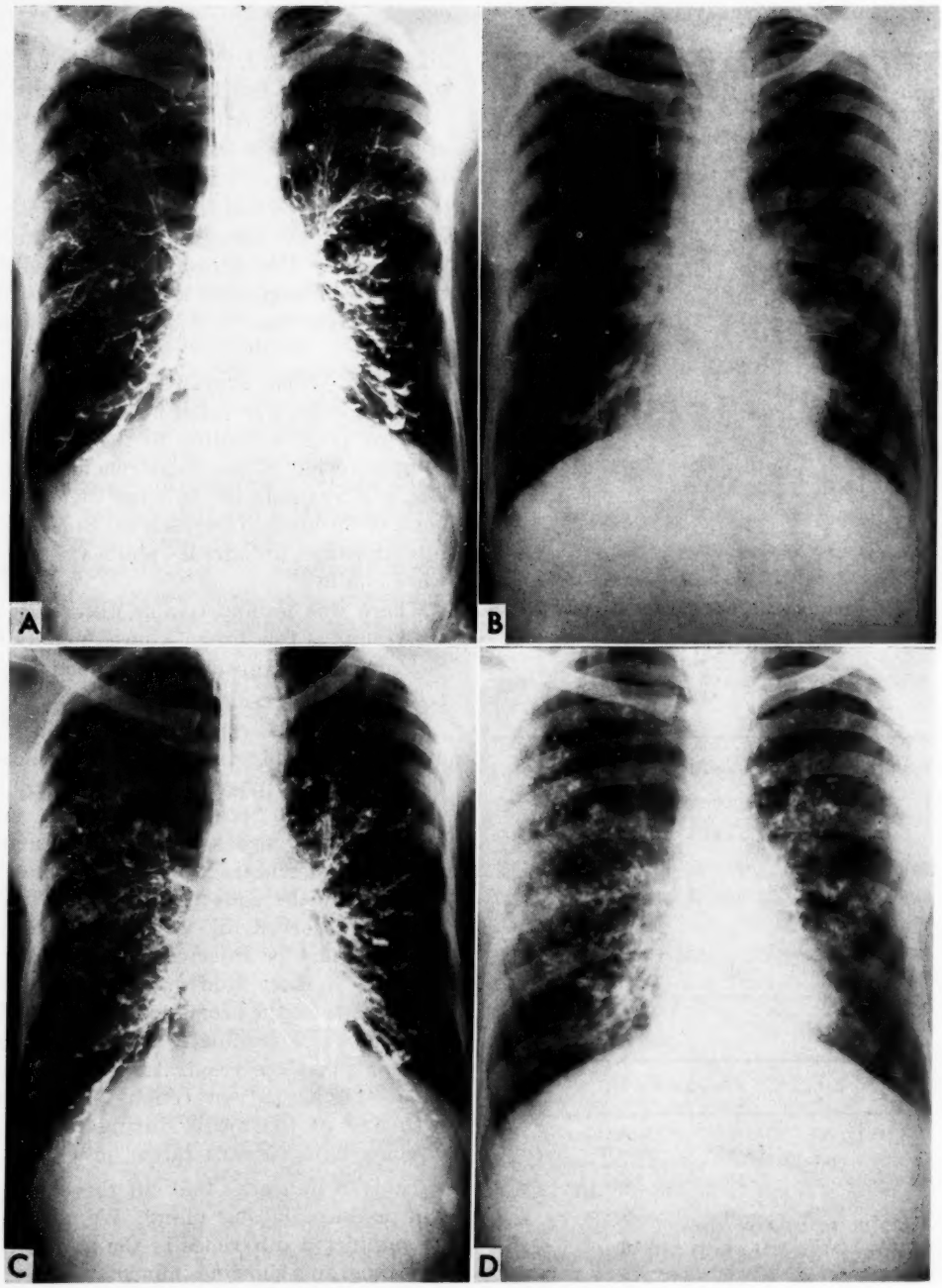

Fig. 2.—D. T., white, male, aged 18. *A*, oily dionosil demonstrates severe degree of bilateral saccular bronchiectasis without alveolar filling. *B*, after five days oily dionosil has almost entirely disappeared from bronchi. A few flecks may be seen at bases, but there is no "infiltrate" to obscure change in disease. *C*, repeat bronchogram with lipiodol. The delineation here is inferior to that in *A*. *D*, film taken one month later, showing residual lipiodol.

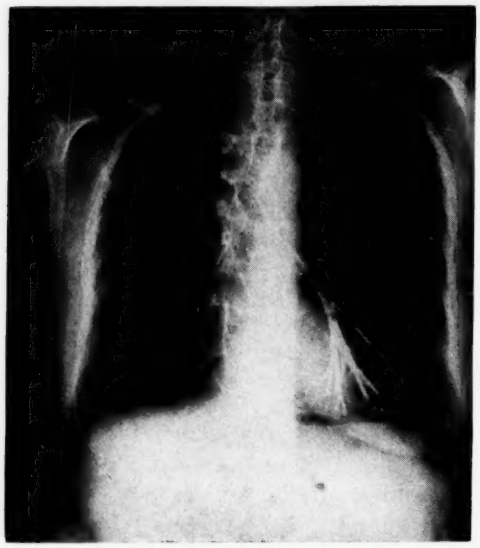

Fig. 3.—Bronchogram with aqueous dionosil in right bronchi and oily dionosil in left. Note superior contrast of oily medium.

TABLE 1.—*Overall Quality of Bronchograms*

	Lipiodol	*Aqueous Dionosil*	*Oily Dionosil*
Excellent	11	12	11
Good	10	11	12
Poor	4	2	2
Total	25	25	25

TABLE 2.—*Alveolar Filling*

	Lipiodol	*Aqueous Dionosil*	*Oily Dionosil*
None	10	14	11
Slight	10	8	9
Moderate	3	0	2
Marked	2	2	1
Interferes with Interpretation	0	1	2
Total	25	25	25

able in this regard. The patient is told not to swallow the dye but to expectorate it with each cough. Attention to such details appears to help in the prevention of complications.

With children and infants the technique is modified by using general anesthesia preceded by the appropriate premedications. Bronchographic studies of patients at such ages can be done quite satisfactorily.[34]

Results.—The overall quality of the bronchograms was judged to be excellent, good or poor, according to the clarity of demonstration of the endobronchial pathologic alterations or, in case there were none, of the bronchi themselves. Some were intentionally unilateral studies; others were bilateral.

There was no appreciable difference in the results of the three. Approximately 85 per cent in each group showed good to excellent overall results.

The dionosils coat the endobronchial mucosa uniformly and demonstrate nicely the smaller peripheral bronchi. There is less tendency to "pool" than there is with lipiodol. More care is required in securing adequate anesthesia with the dionosils, particularly the aqueous, than with lipiodol. We observed, likewise, that aqueous dionosil must be injected slowly, since it seems to be more fluid than the other media. Otherwise the bronchi are flooded with the dye, which stimulates the cough reflex and may produce respiratory embarrassment. If the patient coughs excessively with any of the media during injection, alveolar filling occurs rather promptly.

Table 2 indicates that all three media will produce alveolar filling. We observed no significant difference in the number of bronchograms showing immediate alveolar filling, nor did any one agent seem to produce a greater degree of alveolar filling than did the others. Only occasionally did it interfere with the satisfactory demon-

stration of the bronchi. Evaluation of subsequent films always showed marked filling of the alveoli with lipiodol, but not with the other agents.

The sharpness of the contrast is definitely superior with lipiodol, and this can be obtained with less material. We usually required 15 cc. of dionosil per side to obtain satisfactory visualization, as compared to approximately 10 cc. per side for lipiodol. None the less, the dionosils do afford very satisfactory contrast to demonstrate endobronchial pathologic change. Here again the oily dionosil appears superior to the aqueous. With aqueous dionosil the sharpness of contrast tends to disappear so rapidly that the interval between injection and the roentgen exposure should not be greater than ten minutes. Roentgenograms of the chest taken subsequent to the obtaining of bronchograms revealed complete clearance of the dionosils in nearly all cases within three days and in all cases within five days. Lipiodol was always discernible for as long as a month after injection, often for six months, and in one case for two years.

No deaths or serious complications due to any of the agents occurred in this series. In more than 300 bronchograms (including those of the present study) taken with various media in patients with tuberculosis, no undue effect of the tuberculous lesion has ever been noted. The only significant complication occurred in a patient who had been given aqueous dionosil, early in this series, before careful attention was being paid to removing as much of the medium as possible. Shortly after completion of the bronchograms the patient became dyspneic and cyanotic. Bronchoscopic examination revealed the dionosil to be caked along the entire tracheobronchial tree. Large quantities of this were aspirated, with partial clearing of the symptoms, but it was several hours before the patient was completely normal clinically.

SUMMARY AND CONCLUSIONS

1. A comparative study has been made of the relative merits of lipiodol, aqueous dionosil and oily dionosil for bronchographic studies.

2. Lipiodol appears to be extremely satisfactory except that persistent infiltrates of the medium remain in the lungs for extended periods, obscuring the details of progressive lesions.

3. Aqueous dionosil was relatively unsatisfactory, as it proved irritating and gave the poorest contrast of the three media studied.

4. Oily dionosil proved quite satisfactory, giving excellent bronchograms almost on a par with those obtained with lipiodol, being nonirritating and quickly disappearing from the lung parenchyma.

ZUSAMMENFASSUNG UND SCHLUSSFOLGERUNGEN

Es liegt eine vergleichende Untersuchung der Vorzüge von Lipiodol, wässerigem Dionosil und öligem Dionosil in der Bronchiographie vor.

Das Lipiodol erwies sich als ein zufriedenstellendes Mittel mit der Ausnahme, dass es hartnäckige die Lunge infiltrierende Reste für längere Zeiträume hinterliess, wodurch die feinen Einzelheiten eines fortschreitenden Krankheitsprozesses verdeckt wurden.

Das wässerige Dionosil war verhältnismässig unbefriedigend, weil es Reizerscheinungen hervorrief und von geringerer Kontraststärke als die beiden anderen Mittel war.

Das ölige Dionosil führte zu recht befriedigenden Resultaten und produzierte ausgezeichnete Bronchiogramme, die den mit Lipiodol erzielten fast gleichkamen. Es war reizlos und verschwand nach kurzer Zeit aus dem Lungengewebe.

RÉSUMÉ ET CONCLUSIONS

Une étude comparative a été faite concernant les qualités respectives du lipiodol et du dionisil aqueux et huileux dans les examens bronchographiques.

Le lipiodol s'est montré satisfaisant; mais on peut lui reprocher la persistance d'infiltrations du produit dans les poumons durant une période plus ou moins longue, obscurcissant les détails des lésions progressives.

Le dionisil aqueux est irritant; de plus, sur les trois produits étudiés, il a donné le contraste le moins bon.

Quant au dionisil huileux, il donne des bronchogrammes d'une qualité presque égale à ceux du lipiodol; il n'est pas irritant et s'élimine rapidement du parenchyme bronchique.

RESUMEN Y CONCLUSIONES

Se ha hecho un estudio comparativo de los méritos relativos del lipiodol, del dionosil acuoso y del dionosil aceitoso en estudios broncográficos.

El lipiodol parece satisfactorio excepto por los infiltrados persistentes del medio que queda en los pulmones por períodos extensos de tiempo, oscureciendo los detalles de las lesiones progresivas.

El dionosil acuoso demostró ser relativamente insatisfactorio, proque es irritante y porque, de los tres medios estudiados, es el que dio el contraste meno efectivo.

El dionosil aceitoso fué satisfactorio, dando broncogrammas excelentes, casi a la par de los obtenidos con el uso del lipiodol.

No era irritante y desaparecía rapidamente del parénquima pulmonar.

SUMARIO E CONCLUSOES

Fez um estudo comparativo das vantagens do lipiodol, dionosil aquoso e dionosil oleoso na broncrografia.

O lipiodol mostra-se satisfatorio exceto quanto a demora desse contraste após o exame, obscurecendo os aspectos da evolução das lesões progressivas.

O dionosil aquoso não foi bem aceito por ser irritante e porque, dos três meios de constraste estudados foi o que evidenciou menos eficiência.

O dionosil oleoso foi quasi satisfatorio permitindo excelentes broncogramas ausi identicos aos obtidos com o lipiodol. Não se mostrou irritante e sua permanencia foi breve no parenquima pulmonar.

REFERENCES

1. Colin, G.: Traite de physiologie comparee des animaux. Paris: 1873, 2d ed., vol. 2, p. 108.

2. Green, H.: Sur l'emploi des injections dans les bronches et les cavernes tuberculeuses des poumons, Gaz. hebd. de med. Paris 2:851, 1855.

3. Winternitz, H.: Ueber Jodfette und ihr Verhalten im Organismus, nebst Untersuchungen uber das Verhalten von Jodalkalien in den Geweben des Korpes, Ztschr. f. physiol. Chem. 24: 425, 1898.

4. Sicard, J. A., and Forestier, J.: Methode general d'exploration radiologique par l'Huile Iodee, Bull. et mem. Soc. med. d. Hop. de Paris 46:462, 1922.

5. Jackson, C., and Jackson, C. L.: Bronchoesophagoly. Philadelphia: The W. B. Saunders Company, 1950.

6. Dormer, B. A.; Friedlander, J., and Wiles, F. J.: Bronchography in Pulmonary Tuberculosis, Am. Rev. Tuberc. 51:519, 1945. Boyer, L. B.: Bronchography in Tuberculosis, Am. Rev. Tuberc. 54:111, 1946.

7. Shaw, K. M.; Collins, D. M., and Macnamara, J.: Role of Bronchography in Pulmonary Tuberculosis, Am. Rev. Tuberc. 70:274, 1954.

8. Cabitt, H. L.; Singer, J. J., and Graham, E. A.: Bronchography Following Thoracoplasty for Tuberculosis, J. Thoracic Surg. 5:259, 1936.

9. Huizinga, E.: Bronchography in Bronchial Cancer and Collateral Ventilation, J. Thoracic Surg. 23:445, 1952.

10. Archibald, E., and Brown, A. L.: Dangers of Introducing Iodized Oil into the Tracheobronchial System, J.A.M.A. 88:1310, 1927.

11. Scadding, J. G.: Acute Iodism Following Lipiodol Bronchography, Brit. M. J. 2:1147, 1934. White, B., and Bayliss, C. G.: Acute Iodism Following Lipiodol Bronchography, M. J. Australia 2:421, 1943.

12. Pinckin, A. J. S., and Morlock, H. V.: Acute Massive Collapse of the Lung Following Lipiodol Injection, Brit. M. J. 1:930, 1931.

13. Chesterman, J. T.: Lipoid Pneumonia Due to Iodised Oil, J. Path. and Bact. 54:385, 1942.

14. Mahon, G. S.: Resection Following Bronchography with Iodized Oil, J.A.M.A. 130:194, 1946. Sumner, J.: Lichter, A. I., and Nassau, E.: Fatal Acute Iodism after Bronchography, Thorax 6:193, 1951.

15. Dangers of the Injection of Iodized Oils (Report of the Council on Pharmacy and Chemistry), J.A.M.A. 99:1946, 1932.

16. Ross, I. S.: Pulmonary Epithelium and Proliferative Reactions in the Lungs, Arch. Path. 27: 478, 1939.

17. Rabinovitch, J., and Lederer, M.: Lipoid Pneumonia, Arch. Path. 17:160, 1934. Schneider, L., and Segal, J.: Bronchography with Iodized Oil Not Without Danger, Am. Rev. Tuberc. 35:590, 1937.

18. Wright, R. D.: Reaction of Pulmonary Tissue to Lipiodol. Am. J. Path. 11:497, 1935. Storrs, R. P.; McDonald, J. R., and Good, C. A.: Lipoid Granuloma of the Lung Following Bronchography with Iodized Oil, J. Thoracic Surg. 18:561, 1949. Fortner, H. C., and Miles, J. S.: Iodized Poppyseed Oil Granuloma, Arch. Path. 49:447, 1950. Robertson, P. W., and Morle, K. D. F.: Delayed Pulmonary Complications of Bronchography, Lancet 2:387, 1951. Felton, W. L. II: The Reaction of Pulmonary Tissue to Lipiodol, J. Thoracic Surg. 25:530, 1953.

19. (a) Ballon, D. H.: Lipiodol in the Diagnosis of Bronchopulmonary Lesions by the Bronchoscopic Method, Arch. Otolaryngol. 3:403, 1926 (b) Fried, B. M., and Whitaker, L. R.: Intratracheal Injection of Iodized Oil, Arch. Int. Med. 40:726, 1927.

20. Park, F. R.; Cronk, R. T., and Cronk, G. E.: Prevention of Iodism in Bronchography by Use of ACTH, Dis. of Chest 24:219, 1953.

21. Theodos, P. A.: Bronchography in Iodine Sensitivity, J.A.M.A. 148:1419, 1952.

22. Zavod, W. A.: Functional Pulmonary Changes Following Bronchography, Am. Rev. Tuberc. 57:626, 1948.

23. Burrascano, J. J.: Visciodol in Bronchography, Sea View Hosp. Bull. 15:149, 1955.

24. Morales, O., and Heiwinkel, H.: A Viscous, Water-Soluble Contrast Preparation: Preliminary Report, Acta Radiol. 30:257, 1948.

25. Atwell, R. J., and Pedersen, R. L.: Water-Soluble Contrast Medium for Bronchography, Dis. of Chest 18:535, 1950.

26. Norris, C. M., and Stauffer, H. M.: Bronchography with Dionosil, Ann. Otol. & Rhinol. 63:520, 1954.

27. Hueper, W. C.: Macromolecular Substances as Pathogenic Agents, Arch. Path. 33:267, 1942. Hueper, W. C.: Reactions of the Blood and Organs of Dogs After Intravenous Injections of Solutions of Methylcelluloses of Graded Molecular Weights, Am. J. Path. 20:737, 1944. Peck, M. E.; Neerkin, A. J., and Salzman, E.: Clinical and Experimental Studies in the Use of a Water-Soluble Agent for Bronchography, Surg., Gynec. & Obst. 92:685, 1951.

28. Hess, R.: Pulmonary Changes After Bronchography with Carboxymethylcellulosic Contrast Media, Thoraxchirurgie 1:499, 1954.

29. Peck, M. E.; Neerken, A. J., and Salzman, E.: Clinical Experience with the Water-Soluble Bronchography Compounds, J. Thoracic Surg. 25: 234, 1953.

30. Tomich, E. G.; Basil, B., and Davis, B.: The Properties of n-propyl 3:5-di-iodo-4-pyridone-N-acetate (Propyliodine), Brit. J. Pharmacol. 8:166, 1953.

31. Cummins, C., and Silver, C. P.: Bronchography with a Rapidly Eliminated Compound "Dionosil," Brit. J. Radiol. 26:435, 1953. Holden, W. S., and Crone, R. S.: Bronchography Using Dionosil Oily, Brit. J. Radiol. 26:317, 1953.

32. Elphinstone, N. C.; Iles, K. C., and Laidlaw, E. F.: Use of Dionosil for Bronchography in Pulmonary Tuberculosis, Brit. J. Tuberc. 48:33, 1954.

33. Clerf, L. H.: Pneumonography, Surg., Gynec. & Obst. 41:722, 1925.

34. Rendle-Short, J.: Report on Use of "Dionosil" in Bronchograms in Children, Brit. M. J. 1: 259, 1953.

A patient one day presented himself to Abernethy; after careful examination the celebrated practitioner said, "You need amusement; go and hear Grimaldi; he will make you laugh, and that will be better for you than any drugs." "My God," exclaimed the invalid, "but I *cm* Grimaldi!"

Sección en Español

Tratamiento de la Tromboangiitis Obliterante

El Papel de la Arteriectomia*

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NO existe, que sepamos nosotros, más que una sola publicación nacional, íntegramente dedicada a la enfermedad de Leo Buerger, cual es la Tesis Doctoral de Julio José Sanchez Vegas, presentada ante la I. Universidad Central en 1940 y entre cuyas 7 observaciones, no figura ninguna en la cual se haya practicado el exámen anatomo patológico de las arterias interesadas por la enfermedad.

La importante y exhaustiva Tesis de Rafael Castillo, que abarca el estudio de las arteritis de todo género (1944), cita 6 observaciones con diagnóstico de Arteritis obliterativa de Leo Buerger, de los cuales uno fue un "hallazgo de autopsia" y es el único que ostenta la comprobación anatomo-patológica.

En el documentado e importante estudio del Prof. Miguel Pérez Carreño, presentado ante la Academia Nacional de Medicina y titulado "Contribución al estudio de las arteriopatías periféricas en Venezuela," hay un Capitulo dedicado a la enfermedad de Winiwarter-Buerger, pero tampoco, al parecer, ninguna de las observaciones citadas por el autor, exhibe la comprobación histopatológica que signa la afección, de dificil diagnóstico y facilmente confundible con otra afección general arterial clinicamente muy afín, la arterioesclerosis obliterativa. En la Tesis de Castillo, así como en el trabajo del Profesor Pérez Carreño, hemos encontrado sendos casos que han provocado nuestras dudas respecto al diagnóstico.

A pesar del respeto que la opinión del ilustrado Profesor de Caracas y buen amigo nuestro nos merece, vamos a discutir, (no a negar) el diagnóstico de estos dos casos, comenzando por exponer un breve resúmen de cada uno de ellos.

Caso de Sanchez.—Obs. No. 7, pag. 78.—En mayo de 1935, dolor agudo en pierna izquierda; al cabo de unos meses, claudicación intermitente; viajó a Panamá y Nueva York, donde es tratado sin obtener mejoría.—Al exámen (nov. 1938) corazón ligeramente aumentado a la percusión, T. A. Mx. 140, mn. 100; pulso 80 p.m.; metabolismo normal; ojos: Arterioesclerosis Incipiente. Choroiditis.—Se sienten latidos arteriales. No hay atrofia del pie.—Oscilometría: indice oscilométrico: miembro izqdo. 1½; 2½; 4½ encima de maleolo, debajo de rodilla, encima de rodilla, respectivamente. Miembro derecho: ½; 3; 3½, en los mismos sitios, respectivamente.

Caso de Perez Carreño.—Obs. No. 28, pag. 581.—Enfermo de 41 años hipertenso, hemipléjico izquierdo, operado de simpaticectomia toraco-lumbar izquierda, esplancnicectomia; dolor contínuo en pie izq., claudicación intermitente a pocos metros; contactos bruscos exacerban el dolor; dedos 3° y 4° amoratados

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y frios; tibial anterior y pedia izq. no laten; indice oscilométrico disminuido, especialmente el izqdo.; termometría muy disminuida, especialmente izq. con elemento espamódico presente muy atenuado; hipertrofia ventricular izquierda; lesiones de fondo de ojo grado 2.

En estos dos casos encontramos un síntoma de primerísima importancia en el diagnóstico diferencial entre la Tromboangiitis obliterativa y la Arterioesclerosis obliterativa, cual es la presencia de lesiones esclerosas retinianas, constantes en esta última, y ausentes en general, en la primera. Ahora bien, Sanchez, como si dudara él mismo del diagnóstico, que sinembargo consigna como hecho en Panamá y ratificado en Nueva York, asienta en letras mayúsculas: "Fondo de ojo: Arterioesclerosis Incipiente"; Perez Carreño, a su vez señala que su caso, estuvo hospitalizado en otro Servicio quirúrgico, con diagnóstico de Hipertensión esencial y arteriopatía de tipo Leo Buerger: cuando ingresa a su Servicio, un año después, ya intervenido de toraco-simpaticectomía bilateral y esplancnicectomía, tiene 41 años de edad, Mx 190 y mn 85, hemiplegia izquierda, hipertrofia ventricular izquierda, Keith-Wagner 2 en fondo de ojo: ¿No es cierto que este cuadro evoca mas bien el diagnóstico de arterioesclerosis que el de tromboangiitis?

Sinembargo, a pesar de la importancia que atribuimos al fondo de ojo para el diagnóstico no nos atrevemos a pronunciarnos definitivamente sobre ello, en el primer caso por la autoridad de los medios científicos donde fué dictado el diagnóstico, y en el segundo por estar de por medio la talla científica del antiguo Interno del Hospital Vargas del primero de nosotros, y Profesor de Clínica Quirúrgica del segundo, e indiscutiblemente uno de los cirujanos venezolanos de mas amplia ilustración y experiencia en lo relativo al campo de las arteriopatías.

Desde el punto de vista exclusivamente clínico, Silbert trae el siguiente cuadro para el diagnóstico diferencial entre arterioesclerosis y tromboangiitis.

Nosotros hemos elaborado para nuestras clases de Clínica Quirúrgica, extrayéndolo de lo expuesto por Wright en su Manual of Vascular Diseases in Clinical Practice, el siguiente cuadro:

Tromboangiitis:	*Arterioesclerosis:*
Aparenta menos edad	Aparenta mas edad
Color del cabello normal	Color del cabello generalmente gris
No hay arcos seniles	Frecuentemente presentes
Arterias retinianas normales	Generalmente escleróticas
Presión arterial generalmente baja	Presión a menudo alta
Arterias radial y temporal suaves	Radial y temporal gruesas y duras
Extremidades superiores frecuentemente complicadas	Extremidades superiores rara vez complicadas
Arterias gemorales frecuentemente complicadas	Femorales rara vez obstruidas
No hay calcificación de los vasos a los Rayos X	Calcificación de los vasos frecuente
Volúmen de la sangre generalmente disminuido	Volúmen de la sangre generalmente normal
Síntomas de arterioesclerosis coronaria raros	Síntomas de arterioesclerosis coronaria frecuentes
Aorta aparece normal a los Rayos X	Aorta algunas veces alargada
Albuminuria rara	Albuminuria es común
Historia de flebitis migratoria frecuente	Historia de flebitis migratoria rara

Sintoma y Signo	*Tromboangiitis:*	*Arterioesclerosis*
Comienzo	Juventud (30-35 años)	Tardío (45-50 años)
Flebitis y edema	Presentes	Ausentes
Ulceraciones	Húmedas, profundas dolorosas	Secas, superficiales, (excepto en diábetes) excepcionalmente dolor
Radiografía	no calcificación	Calcificación
Trayecto arterial:	no tortuoso	tortuoso, desliza baja el dedo
Consistencia:	normal	arterias duras
Pulso:	raramente modificado	hipertensión frecuente
Fondo de ojo:	normal generalmente	alterado (esclerosis retiniana)

Castillo, en su Tesis antes citada, apunta lo siguiente: "Este es un exámen (el del fondo de ojo), que debe ser hecho en todos los enfermos que demuestren cualquier sintomatología respecto a insuficiencia circulatoria." "Es necesario que conozcamos que las arteritis no son enfermedades locales, sino enfermedades generales con manifestaciones locales; que una vez que un agente tóxico ha entrado en el torrente circulatorio llegará igualmente a los vasos de la retina, como a los capilares de una viscera del abdómen o del torax o a los pequeños vasos que nutren los tejidos de las partes distales de los miembros inferiores. En nuestros casos, los fondos de ojo fueron normales en los pacientes de enfermedad de Buerger y en la arteritis infecciosa." "En los casos de arterioesclerosis, el fondo de ojo nos suministró datos de esta enfermedad que coincidían con la clínica, algunas veces comprobados por la anatomía patológica; en las arteritis específicas, el fondo de ojo siempre nos suministró datos referentes a lesiones de capilaritis."

Sin pretender apartarnos del concepto ortodoxo de que la Tromboangiitis es una enfermedad general del árbol vascular, he aquí lo que apuntan Allen y Barker respecto a las lesiones tromboangiiticas de las arterias viscerales: "En casos de tromboangiitis obliterante de las extremidades, pueden desarrollarse enfermedades arteriales oclusivas de varios órganos viscerales. En muchos de los casos descritos, el diagnóstico se basó unicamente en los rasgos clínicos, y la naturaleza exacta de la lesión de las arterias viscerales no se determinó. Cuando se efectuó la necropsia, casi siempre se halló que las lesiones oclusivas de las visceras, eran mas bien de arterioesclerosis que de tromboangiitis obliterante."

Examinando las Historias de la Clínica Mayo, Hausner encontró 56 de ellas con diagnóstico de Tromboangiitis obliterativa y oclusión de las coronarias; pero la autopsia comprobó tan solo 7 casos con lesiones inflamatorias de dichas arterias.—El mismo Hausner y Allen, revisando la literatura, encuentran 34 casos de Tromboangiitis con lesiones de las arterias cerebrales; los signos clínicos de estos casos eran transitorios o permanentes y consistían en hemiplegia recurrente, episodios de confusión mental y hemianopsia; solo en 3 de estos casos se hallaron lesiones inflamatorias marcadas de las arterias cerebrales, pero esas lesiones diferían al gunos rasgos de las lesiones típicas de tromboangiitis encontradas generalmente en las arterias de las extremidades.

Por su parte, Leriche, en su monumental obra "Les thromboses artérielles," escribe textualmente: "Los accidentes cerebrales son mas raros, pero existen. Recuerdo un tromboangiitico joven que presentó una

hemiplegia súbita, y recientement, un hombre de 38 años, presentó afasia y hemiparesia, algunas semanas despues de una doble gangliectomia lumbar." "A veces he notado trastornos oculares, amaurosis pasajeras o trastornos visuales definitivos." Aun cuando Leriche piensa que con la mayor frecuencia y acuciosidad de los exámenes sistemáticos actualmente practicados, el número de estos casos aumentará, es lo cierto que insiste en el carácter regresivo de estas lesiones facilmente asequible por infiltraciones del ganglio estelar, y que los casos que cita como de accidentes coronarios y cerebrales tromboangiiticos, no tienen tampoco la comprobacién irrebatible del exámen necrópsico o histo-patológico.

No ha sido nuestra intención, al comentar los casos de Sanchez y Perez Carreño, la improcedente y estéril crítica de un diagnóstico ajeno: lejos de ello, solo nos ha movido el poner de manifiesto, ante los colegas de esta distinguida Sociedad, 1) nuestra convicción de que existe a penas un exiguo número de casos que pueden catalogarse ciertamente como arteritis tipo Buerger; 2) la justeza de la posición de quien, ante un presunto tromboangiitico con lesiones coronarias o cerebrales esboza un gesto de duda; 3) la conveniencia de basar el diagnóstico de la enfermedad de Winiwater-Buerger, sobre el irrefutable argumento del exámen histo-patológico.

Esta comprobación histológica es tanto mas necesaria, cuanto que las dos afecciones, tromboangiitis y arterioesclerosis, pueden coexistir en un mismo individuo, y se comprende bien la dificultad de deslindar con los solos recursos de la clínica la sintomatología que corresponde a cada una de ellas, ya que presentan una larga serie de síntomas y signos comunes y que las exploraciones clínicas usadas para el diagnóstico son similares.

Propugnamos el exámen histo-patológico con tanta mayor insistencia, cuanto que, en la inmensa mayoría de los casos, una arteriectomía del segmento obliterado será en extremo beneficiosa, definitiva o temporalmente, tanto para el tromboangiitico como para el arterioesclerótico.

Fué el ilustre Leriche, en mala hora desaparecido para la Cirugía mundial, el primero en hablar de arteriectomía, desde 1916 cuando descubrió que, a pesar de la interrupción de la circulación por el vaso principal, la cantidad de sangre que llega a la periferia aumenta, las extremidades se recalientan, los trastornos vaso-motores desaparecen, y hasta las oscilaciones reaparecen o aumentan siquiera sea debilmente, cuando se extirpa el segmento arterial trombosado.

He aquí como explica el propio Leriche este hecho paradójico: "Una sola explicación es posible: la trombosis, al modificar la pared arterial, produce excitaciones de los nervios centrípetos. Estas se reflejan como acciones constrictivas sobre las vias colaterales, únicas que pueden asegurar la circulación agravando así el déficit. La arteriectomia constituye una neurectomia sensitiva que suprime el punto de partida de los reflejos motores y coloca las colaterales que nacen de la arteria interesada en estado de vaso-dilatación."

Los efectos favorables de la arteriectomio en casos de obliteración arterial pueden esquematizarse como sigue:

1) Detiene la trombosis: la trombosis es un fenómeno progresivo, que marcha por etapas, pero que no se detiene espontáneamente; el choque de la onda sanguínea contra el trombo, provoca su crecimiento, especialmente en su extremo proximal. Fontaine, discípulo de Leriche, ha demostrado que cuando se provoca experimentalmente una obliteración arterial limitada, aparecen, mas allá de la obstrucción, focos endarteríticos secundarios que pueden llegar hasta la desaparición completa de la luz arte-

rial; hecho que nunca se presenta si se practica la arteriectomia.

2) Acción analgésica: es un hecho de observación, tanto en cirugía de guerra como en prãctica civil, la aparición de dolores, consecutivamente a la obstrucción arterial, que incluso llegan a adquirir las características de una verdadera causalgia, dolores que desaparecen con la resección del segmento arterial trombosado.
3) Suprime los reflejos arterio-arteriales vasoconstrictores patológicos, y cambia el régimen circulatorio periférico, lo que explica el regreso de las oscilaciones y el aumento de la temperatura cutánea, que tienden ambos a acercarse a la normal, debido evidentemente a la vaso-dilatación de las colaterales consecutivamente a la resección del segmento arterial obstruido.

Papel de la Arteriectomia en el Tratamiento de las arteritis, especialmente de la Tromboangiitis:

Antes de emprender la crítica de cualquier tratamiento empleado contra la tromboangiitis de Buerger, es necesario tener muy presente el carácter progresivo, lento o rápido, pero siempre interrumpido por largos períodos de calma o por lo menos de latencia, que caracterizan la enfermedad, para no atribuir al tratamiento, lo que no es sino el resultado de la evolución natural del mal.

Para la selección del tratamiento, es necesario tambien, tener en cuenta que la tromboangiitis es "una enfermedad de sistema y no de órgano": todos los componentes del sistema circulatorio son atacados por ella: las arterias, las arteriolas, las venas, el simpático vaso-constrictor. Respecto al factor etiológico, de trascendencia tambien para la aplicación de un tratamiento realmente eficaz, es lo cierto que actualmente es imposible pronunciarse definitivamente sobre él, y que posiblemente no existe un agente único causante de la tromboangiitis.

En realidad, continuan siendo ciertas las palabras del Profesor Julio Diez, cuando dice que hasta el presente, no se conoce "ningún método terapéutico que actúe directamente sobre el proceso íntimo de la tromboangiitis y pueda ser considerado por lo tanto como medicación específica," pero es cierto tambien que entre los agentes etiológicos de la enfermedad de Buerger aparece como preponderante la acción del tabaco. Silbert, Wright, etc. no han encontrado un solo caso de enfermedad de Buerger en no fumadores; Wright ha demostrado experimentalmente la acción vasoconstrictora de la inhalación del humo de tabaco y cigarrillos, la cual provoca una caida de la temperatura cutánea que alcanza una media de 5°3 C, con máxima hasta de 8°5 C, experiencias que han sido confirmadas por Maddock y Coller, Barker, Roth y otros; por el método pletismográfico, Lampson ha llegado a idénticas conclusiones. La tromboangiitis antes desconocida en la mujer, ha comenzado a hacer su aparición entre ellas, pero los casos descritos han ocurrido siempre en fumadoras.

En cuanto al mecanismo de la acción del tabaco, la verdad es que no existe tampoco conclusión definitiva al respecto: pudiera ser por acción de la nicotina sobre las glándulas suprarrenales, a cuyo favor está la hiperglicemia concomitante con la vasoconstricción desencadenada por el acto de fumar; o por acción directa sobre los centros cerebrales, sea separadamente por dos mecanismos, uno directo sobre la vasoconstricción y otro por intermedio de las suprarrenales, o bien por efecto sobre el area cerebral que controla las suprarrenales solamente; o por último, por acción directa de la nicotina sobre las terminaciones nerviosas vasculares vaso-constrictoras. Tampoco ha de olvidarse una posible acción alérgica del tabaco.

Con tantos elementos a que atender se comprende que no pueda propugnarse un tratamiento único y sistematizado para todos los casos de tromboangiitis: como quiera que éllo sea, la realidad es que con los modernos tratamientos se ha logrado reducir la rata de amputaciones que antiguamente alcanzaba mas del 70% hasta menos del 5%.

Sintomáticamente, como dice Leriche, toda la enfermedad está dominada por el espasmo, contra el cual, afortunadamente, estamos bien armados y que podemos combatir por los medios siguientes:

a) por la *arteriectomía*, cuyo carácter dominante de intervención vaso-dilatadora la hace similar a la gangliectomía, cuyos resultados buenos o mediocres, comparte;

b) por la *gangliectomía lumbar*, la cual, cuando la circulación periférica está todavía asegurada por la replesión a contra-corriente de la via principal mas allá de la obliteración, da resultados notables, pudiendo hablarse de curación durante años, y a veces definitivamente. Pero aún así, esta intervención no ataca la condición etiológica, y la enfermedad es capaz de reiniciar su evolución, despues de una larga, aparente detención. La operación de Diez cura los síntomas, no cura la enfermedad. (Leriche)

c) por la *adrenalectomía*, única intervención que ha dado resultados completos y duraderos (15, 16 años), hasta el punto de que en opinión de Leriche, se podría hablar de curación definitiva, sin nuevos brotes evolutivos ni nueva localización del mal. Pero, desgraciadamente, la operación de von Oppel no asegura ni mucho menos de manera absoluta la detención de la enfermedad; ora, porque practicada demasiado tarde, cuando existen ya trombosis que evolucionan por su propia cuenta; ora porque se ejecuta una intervención insuficiente, no extirpándose sino una glándula o sea la mitad del tejido endocrínico responsable o bien porque la glándula restante se hipertrofie y adquiera una mayor actividad. Estos hechos son fundamento de quienes opinan que en la base etiológica de la tromboangiitis es necesario tomar en consideración un desequilibrio endocrínico suprarrenal. Para obviar una posible hipertrofia de la suprarrenal restante, hay quienes aconsejan la sección de los esplancnicos.

Desde el punto de vista anatómico y fisiológico, no es fácil la supresión del trastorno circulatorio: un arteriectomizado, un simpaticectomizado lumbar, un adrenalectomizado, aun cuando reaparezcan las oscilaciones, aun cuando la temperatura cutánea vuelva a la normal, permanece en las mismas condiciones de un arterítico obstruido: con objeto de remediar esta situación, Reynaldo dos Santos resucitó, hace ya mucho años, la primitiva idea de Leriche, de reemplazar el segmento arterial trombosado por un injerto venoso; ignoro hasta que punto se han proseguido las experiencias de dos Santos h., quien logró el funcionamiento correcto de injertos venosos en perros; posteriormente se han practicado injertos arteriales (Leriche, Fontaine, etc.).

Mas tarde, se pensó por un momento que la solución estaba en la "endarteriectomia desobliterante" de Bazy y Réboul, modificación de la primitiva técnica de la endarteriectomia de dos Santos h., la cual consiste en la extirpación, a cielo abierto de la endoarteria y el trombo en un solo bloque, con lo cual se ha logrado, en muchos casos, repermeabilizar los vasos trombosados, a veces definitivamente; pero aparte de que los resultados finales de esta intervención no son mejores que los de la arteriectomia, sus dificultades técnicas y

su gravedad son infinitamente mayores. Ademas, es susceptible de la misma objeción que se le puede hacer a la arteriectomia, es decir, que puede llegar hasta curar el fenómeno local, pero que no tiene influencia alguna sobre la enfermedad en sí.

Tal vez sea factible tambien, con el material plástico actualmente usado para el tratamiento de los aneurismas arteriales, emprender experiencias e intervenciones para reemplazar el segmento arterial trombosado, sobre lo cual no he encontrado dato alguno en la literatura revisada;[1] pero la objeción presentada a propósito de la arteriectomia, conserva en este caso, todo su valor.

De todos modos, es condición imprescindible para dos Santos, antes de emprender estas intervenciones, gangliectomias y adrenalectomias en un arterítico, practicar previamente:

1) la arteriografía, que nos ilustra sobre la circulación colateral y sus características,
2) la infiltración novocaínica del simpático, que nos suministra una idea de la respuesta de la inervación periférica a la intervención. En rigor esta infiltración podría reemplazarse por el uso de los ganglioplejicos.

En resúmen pues, nosotros creemos que el tratamiento quirúrgico de un tromboangiitico debe comenzarse por una arteriectomía del segmento trombosado, tan amplia com sea posible, lo cual nos reporta las siguientes ventajas:

1) mejoría del paciente por vaso-dilatación colateral;
2) posibilidad de un diagnóstico de certeza por el exámen histopatológico de la pieza;
3) posibilidad de practicar posteriormente una intervención de mas aliento (Diez, von Oppel) si los resultados de la arteriectomia, combinados con la supresión del cigarrillo y algún tratamiento médico adyuvante, se muestran insuficientes en sus resultados.

Porque, en nuestro concepto, el tratamiento debe ser mixto, es decir, médico y quirúrgico. Como primera medida, condición *sine qua non*, la supresión absoluta y definitiva del tabaco; en seguida los pequeños medios higienicos consistentes en el cuidado de manos y pies, correcto tratamiento de las dermatofitosis, el reposo en cama, etc., el empleo de los vaso-dilatadores, desde el alcohol, la papaverina, los extractos pancreáticos desinsulinizados, hasta los medios físicos (calor húmedo, etc.), y los ganglioplejicos; los ejercicios musculares sistematizados por Buerger; las soluciones salinas hipertónicas preconizadas por Silbert y el citrato de sodio, algún tanto en desuso actualmente; la proteinoterapia inespecífica con vacuna tifoidea, enfáticamente recomendada por Wright, y usada ampliamente por este autor, Brown, Allen y colaboradores, y cuyo valor, al decir del mismo Wright ha sido definitivamente establecido.

Si no existe el acuerdo perfecto sobre el empleo de los vaso-dilatadores generales del tipo del priscol o de la padutina, por la consideración, tal vez algún tanto teórica de que debido a la vaso-dilatación general del sistema por ellos producida habría una disminución relativa de la volemia en los vasos menores y por lo tanto una mayor isquemia a nivel del territorio correspondiente a las arterias comprometidas por la enfermedad, amen de la vasoconstricción reaccional consecutiva que afectaría tambien los vasos dañados, incrementando la oligoemia a su nivel, en cambio el acuerdo es perfecto cuando se trata del empleo de los ganglioplejicos.

[1]Despues de leido este trabajo ante la Sociedad Medico-quirurgica del Zulia, hemos recibido el N° de Abril de Surgery, Gynecology and Obstetrics, en el cual los Dres. Eddwards y Tapp en un articulo titulado "Peripheral artery replacement with chemically treated nylon tubes" (Surg., Gynec. & Obst., 102, 4, April '56, 443-449) relatan tres casos de trombosis arterial (no precisan la causa), tratados por injertos de nylon, con excelentes resultados hasta el momento.

Nosotros hemos usado los ganglioplejicos que desde el punto de vista teórico llenan una indicación perfecta, haciendo la sección química del simpático vascular de la región atacada por el morbo, obteniendo resultados muy disímiles: en el caso que citamos en este escrito, usamos el Bistrium, en aquel tiempo en experimentación en nuestro pais, sin obtener mayores resultados favorables; desde luego, el uso de la infiltración novocaínica del simpático lumbar tiene aquí, de manera similar al empleo de los ganglioplejicos, el doble papel de agente terapéutico selectivo y de prueba terapéutica previa a la sección quirúrgica del simpático lumbar.

Un modo de tratamiento que queremos hacer resaltar, es el empleo de la vacuna antitífica, ya empleada por Sanchez en su Obs. N° 6, quien obtuvo "un fracaso rotundo," mientras el tratamiento con suero salino hipertónico culminaba sistematicamente en todos los casos en la curación del paciente.

Nuestra experiencia con el empleo de la vacuna en la observación que mas adelante relataremos, es completamente distinta; no queremos ilusionarnos por ello, pues además de que se trata de una sola observación, tenemos además bien presente el modo peculiar de evolución de la enfermedad, como hemos hecho notar, entrecortada por largos periodos espontáneos de receso; y por lo tanto no queremos atribuir a la vacuna, la mejoría de nuestro enfermo; pero es lo cierto que ninguno de los procedimientos anteriormente empleados había producido en nuestro enfermo una mejoría mas acentuada ni mas duradera que la obtenida a raiz del empleo de la vacuna antitífica endovenosa. Bien es verdad que ella fué empleada inmediatamente despues de la arteriectomia de la poplitea, intervención que hemos querido tambien destacar en este artículo: en realidad queremos llamar la atención sobre la combinación arteriectomia-vacuna antitífica-tratamiento sintomático, como método sistematizado de tratamiento de las arteritis tipo Buerger de los miembros inferiores.

De hecho, desde que el Prof. Dr. Julio Arraga practicara en el Hospital de Chiquinquirá por primera vez, en Maracaibo, si nuestras informaciones no están erradas, la simpatectomía lumbar con diagnóstico clínico de arteritis tipo Buerger, en 1949, obteninedo un éxito inmediato completamente satisfactorio, que se mantiene hasta el presente; intervención repetida por los autores de este escrito en un individuo de nacionalidad italiana, con recuperación anatómica y funcional perfecta, que se mantiene tambien hasta hoy (operado en 1951), no tenemos noticia de que en nuestros Hospitales se hayan obtenido mejores resultados, que los que hoy relatamos con la combinación de la arteriectomía y la vacuna antitífica.

Los autores citados usan antígeno Tifoideo H de Lilly o una vacuna especialmente preparada al efecto por Kirk Biological Laboratories.

La dilución de 100.000.000 de bacilos tifoideos permite una dosificación exacta. Pueden presentarse reacciones severa si se trata de medir pequeñas dosis de vacuna partiendo de altas concentraciones. Las suspensiones sedimentan y deben agitarse completamente antes de usarlas.

He aquí como prescribe Wright el empleo de la vacuna:

La primera dosis es de 5.000.000 de organismos. Las inyecciones se aplican cada tres dias con tal que el efecto de la anterior haya desaparecido por completo. El objeto es alcanzar un incremento de temperatura de 2-3 grados F° (±1, C°) en la temperatura oral o rectal, sin que se produzca escalofrio. Aun cuando hay de ordinario un pequeño descenso en la temperatura superficial antes del alza, este enfriamiento no tiene importancia, con tal que no se presente escalofrio. La tem-

peratura superficial de los pulpejos de extremidades normales sube hasta 4-6 F°; en una extremidad enferma, el alza de la temperatura cutánea está influenciado por el grado de oclusión del sistema arterial del miembro, inclusive los colaterales.

Si 5.000.000 de organismos son incapaces de producir fiebre, se aumenta la dosis hasta 8 o 10.000.000 y se mantiene esta dosis hasta tanto la respuesta es satisfactoria. Cuando la dosis anterior es insuficiente, se aumenta de 3 a 5.000.000. Cuando la temperatura sube más allá de 103 F° (39½ C° mas o menos) o si se presenta un escalofrio, la dosis siguiente se reduce en "3 a 5.000.000" de organismos. Han sido suministradas dosis de 200.000.000 y más, pero con la mayoría de los pacientes la dosis máxima alcanza de 70.000.000 a 130.000.000 y esta dosificación puede continuarse indefinidamente. Procediendo cuidadosamente de esta suerte, no hemos tenido efectos desagradables imputables con seguridad al tratamiento. Durante las infecciones agudas intercurrentes u otras enfermedades graves, se ha suspendido el tratamiento. Este tratamiento se continúa por dos o tres meses después de la completa cicatrización de los ulceraciones (Wright, loco citato).

Los resultados de este tratamiento, según Wright, han sido altamente satisfactorios, obteniéndose el alivio del dolor despues de la segunda o tercera inyección y la rápida cicatrización de las lesiones. Los procesos gangrenosos, como es natural, responden más despacio, e incluso se registran algunos escasos fracasos, pero los resultados han sido en general, más beneficiosos con la vacunoterapia, que con cualquier otro medio de tratamiento endovenoso. La vacuna tifoidea no parece tener influencia alguna sobre el sindrome de claudicación intermitente.

En resúmen, pues y como conclusión de las consideraciones anteriormente expuestas, proponemos sistematizar por via de estudio, el tratamiento de las arteritis tipo Winiwarter-Buerger, en la forma siguiente, que constituye una especie de escala ascendente:

1) supresión del tabaco, pequeñas medidas higiénicas, ganglioplejicos, ejercicios tipo Buerger, etc.
2) arteriectomia, aprovechando para practicar el exámen histi-patológico, que nos dará el diagnóstico preciso;
3) vacuna ántitifoidea, ganglioplejicos, infiltración novocaínica, tratamiento sintomático;
4) operación de Diez;
5) operación de von Oppel;
6) excepcionalmente, amputación.

En seguida insertamos un extracto de la Observación clínica que ha servido de base al artículo anterior:

Hospital de Chiquinquirá-Maracaibo, Venezuela—Historia n° 9.179-Sala Rendiles-Cama 1-Ingreso: 8 diciembre 1954—Nombre: A. G., soltero.—Se trata de un paciente de 21 años, natural de San Francisco, limpiador de automóviles; antecedentes hereditarios y personales sin mayor importancia; fuma un paquete de cigarrillos diariamente.

Ingresa por dolor intenso en los tres dedos internos del pie derecho y pantorrilla del mismo lado; hace tres meses presenta claudicación intermitente; ultimamente, dolor en reposo hace tres semanas aparece pequeña ulceración en cara plantar dedo gordo derecho.

Al exámen clinico, paciente de 1,66 de talla; 49 k. peso; T. A. Mx 110, mn 80; pulso 108; temp. 37° C; resp. 17 pm.—Aspecto general enfermizo, tez pálida; dolor intenso en garganta del pie derecho y tres primeros dedos; posición del miembro colgante. Pie derecho edematoso, pierna atrófica, masas musculares hipotónicas; en el dorso del pie derecho, zona irregularmente triangularde base distal, de color pardo negruzco a trechos vilácea, con flictenas; una linea precisa separa esta

zona de la piel sana (Fig. 1, *A* y *B*).

En la cara plantar correspondiente a la misma zona hay una ulceración de un cm. de profundidad que rezuma un líquido oscuro, espeso, mal oliente. Piel fria y sudorosa (sic).

La arteria femoral late bien; la poplitea, tibial anterior y pedia, no laten; las arterias del miembro izquierdo laten normalmente. Oscilómetria: ver fig. 2 (oscilómetro de Collens). Termometria: ver fig. 3 (Dermalor Tycos).

Cosasesco negativo; replesión venosa de Collens, fuertemente positiva.—El ángulo de suficiencia circulatoria y el tiempo y distancia de claudicación no pudieron investigarse debido al intesndo dolor del enefermo.—Rubor de declive, aumentado.

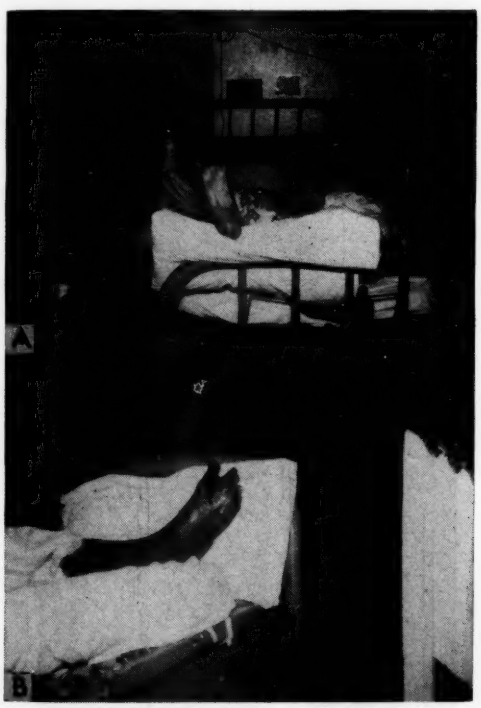

Fig. 1.—*A*, fotografia del pie del paciente (cara dorsal) al entrar al Servico. *B*, fotografia del pie (cara plantar) en la misma época.

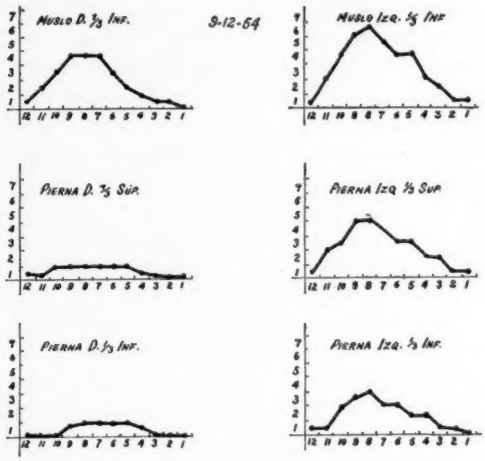

Fig. 2.—Curvas oscilométricas (Collens) al ingresar el paciente.

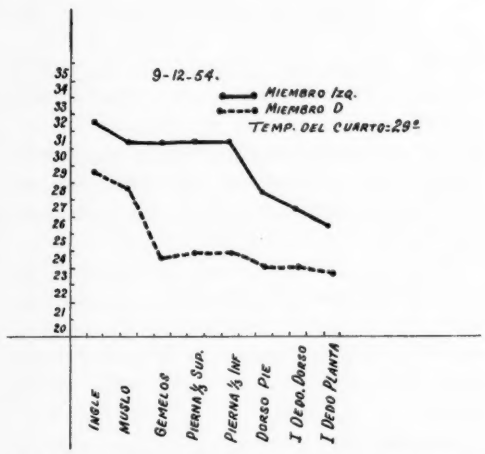

Fig. 3.—Curvas termométricas (Dermalor) en la misma época.

Exámenes de laboratorio: Kahn: 0; Glicemia: 1,08;—Urea: 0,50;—CRG: 3.860.000;—Hgbl.: 78%;—CBG: 32.000;—Indice de Katz: 30;—Hemograma de Shilling: N 86%;—T. sangria: 2'15"; T. coagulación: 5';—Tiempo protrombina 16";—Orinas: normal;—Heces: O—Radioscopia broncopulmonar: normal.—Exámen de fondo de ojo: normal.

Evolución: Se inició el tratamiento con alocaina (novocaina) endovenosa a dosis creciente; tromexan; penicilina-estreptomicina; priscol oral, sin obtenerse mejoria. El 14-12-54 se inicia tratamiento con Bistrium; se tentó la susceptibilidad del paciente con 0,2 cc. intramuscular; a los 30 m. 0,4, de alli en adelante 1 cc. c/. 8 hs.—Se continuó la penicilina-estreptomicina, tromexan; metionina, cinaronk.—Control del tiempo de prtrombina: 16″.

Durante este lapso hubo necesidad de emplear frecuentemente Demerol para aliviar los dolores del paciente; el estado local del miembro afectado permanecia sin variación apreciable.

23-12-54: Se practica arteriografia (Fig. 4) y se aprovecha la herida operatoria para hacer una simpatectomia perifemoral (Dr. Fernández Auvert). El paciente experimentó leve mejoria, incluso con modificación levemente favorable de la curva oscilométrica, mejoria que sinembargo durósolo dos dias. Se practicaron inyecciones endoarteriales de priscol-papaverinassin que el estado del paciente se modificara favorablemente de manera apreciable.

29-12-54: Arteriectomia de la poplitea (Dr. Hernández d'Empaire). Se extirpa segmento artreial trombosado de unos 6 cms. de longitud y se remite la pieza operatoria al Laboratori de Anatomia patológica.

Informe del anatomo-patólogo—(Prof. Gerhard Franz)—Biopsia No. 2216/54:

Exámen macroscópico: Fragmento de un vaso con el aspecto de una arteria y con 2 cms. de longitud y 0,8 cms. de espesor. La luz está aparentemente obliterada por un tejido gris-marron.

Exámen microscópico: Arteria de tipo muscular obliterada por un tejido fibroso rico en vasos y pobre en células que muestra ocasionalmente algunos gránulos de hemosiderina. La elástica interna está bien conservada, se presenta ondulada y muestra en algunos sitios una duplicidad. No se observan procesos inflamatorios evidentes en las capas del vaso. La capa adventicial se presenta fibrosa. Tampoco se aprecian las alteraciones que se encuentran en una arterioesclerosis, como hialinosis de la intima, focos ateromatosos en la misma, fibrosis y calcifiación de la capa media.

Diagnóstico: Tromboangiitis obliterante (v. Winiwarter-Buerger; Fig. 5).

Despues de la arterectomia se continuó el tratamiento con penicilina-estreptomicina, Roniacol, Vitamina B_{12}; Testosterona y Vitamina E. Hasta el 2-3-55 el enfermo experimentó gran mejoria funcional y fisica, para volver luego a presentar la misma sin tomatologia, especialmente dolor intenso, de predominio nocturno. Los latidos arteriales no habian sufrido modificación.

18-3-55: Se inicia tratamiento con vacu-

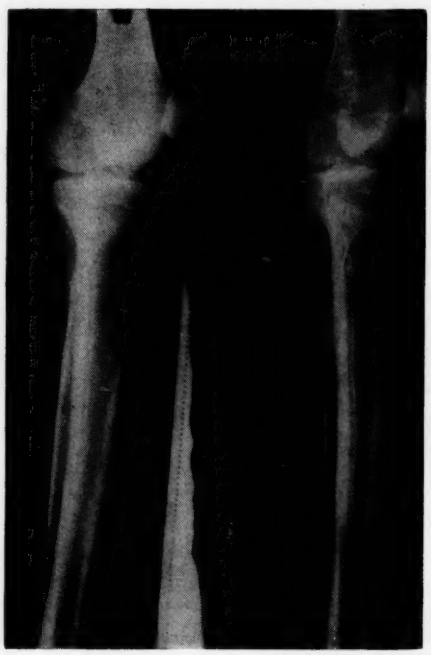

Fig. 4.—Arteriografia el 23-12-54.—Puede verse la brusca interrupción de la poplitea, por encima del condilo interno; colaterales bien desarrollados.

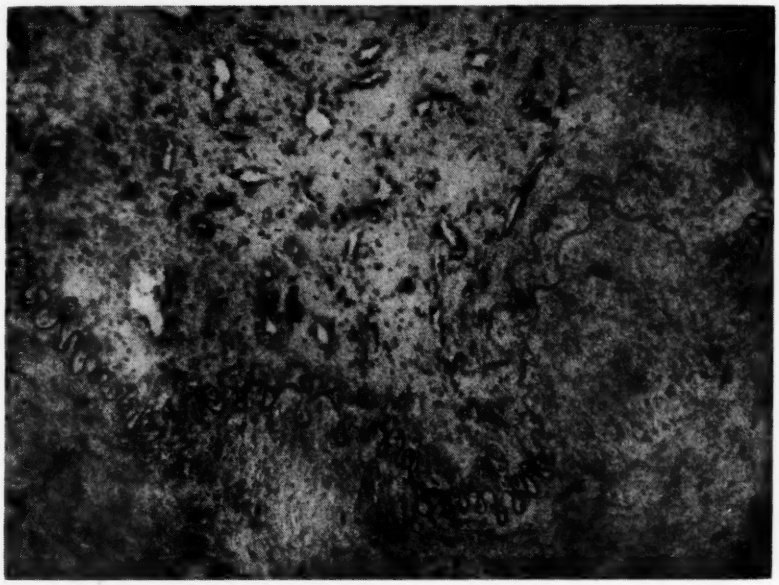

Fig. 5.—Microfotografia de un sector de la arteria poplitea alterada: se observa un tejido fibroso vascularizado que llena la luz. La elástica interna se nuestra bien conservada. No hay alteraciones correspondientes a una arterioesclerosis.

na antitifica, siguiendo las directivas de Wright: a la quanta intección se realizó la amputación espontanea de la primera falange del tercer dedo.

La inyección de vacuna hubo de ser suspendida por afección gripal intercurrente. El tratamiento concomitante con la vacuna consistió en Padutina, Testosterona, y curas locales con Bephanthene Roche.

Despues de la tercera inyección de vacuna, se observó notable mejoria de toda la sintomatologia, especialmente del dolor; la zona de gangrena se limitó netamente y se inició el proceso de cicatrización de las lesiones dejadas por la amputación espontánea de los dedos. El enfermo empezó a caminar por la Sala del Hospital. La temperatura cutánea mejoró notablemente y aun cuando no se percibian latidos arteriales, la oscilometria se modificó favorablemente (Fig. 6).

El 10-5-55 el enfermo fué dado de alta por su voluntad y diez dias despues se practicó la extirpación quirúrgica de un secuestro óseo del tercer dedo, suturandose la herida quirúrgica, la cual cicatrizó por primera intención. En el curso de la inter-

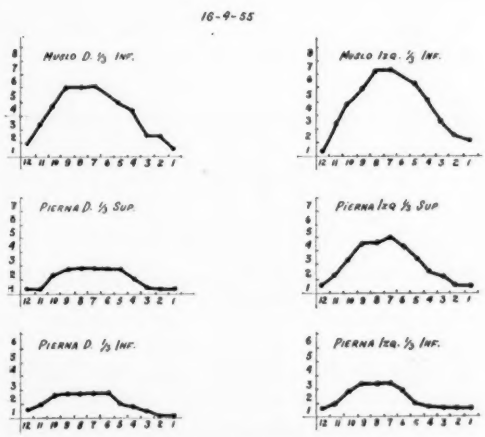

Fig. 6.—Oscilometria practicada el 16-4-55, varios meses despues de la arteriectomia y durante la vacunoterapia. Notese el ascenso del perfil oscilométrico del miembro afectado.

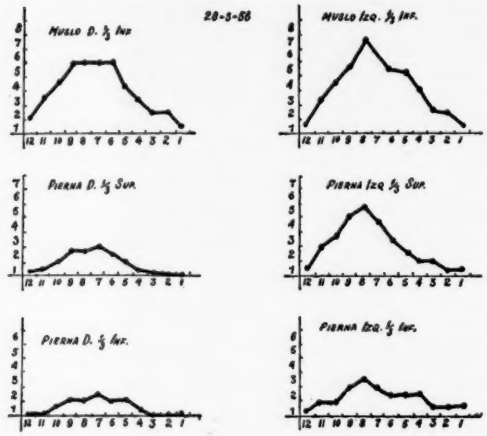

Fig. 7.—Oscilometria el 28-5-56, un año despues de la arteriectomia y vacunoterapia: la curva oscilométrica se mantiene sensiblemente a los mismos niveles alcanzades hace un año.

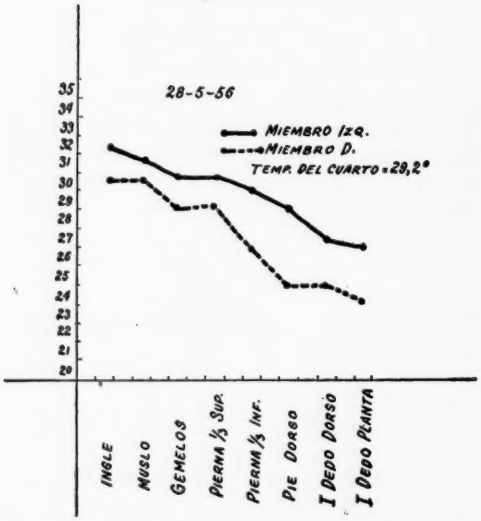

Fig. 8.—Termometria (Termómetro UMA) el 28-5-56, un año despues del tratamiento.

vención pudo notarse que los tejidos sangraban como en un caso normal. Tratamiento subsiguiente: Vitamin E, Vitamin B_{12}, Padutina en comprimidos, Hidergina sub-lingual.

En las Fig. 7 y 8 pueden observarse las curvas oscilométrica y termométrica tomadas el 28-de mayo de este año, es decir, mas de una año despues del tratamiento; las Fig. 9, *A* y *B*, son fotografias del aspecto del pie en la misma época, en que el enfermo fué presentado a la Sociedad Médico-Quirúrgica del Zulia, en la oportunidad de la lectura de la presente observación.—En esta oportunidad, el exámen de fondo de ojo fué normal.

Damos las gracias al Dr. L. Antonorsi por los exámenes de fondo de ojo y al Dr. Gerhard Franz, Profesor de Anatomia Patológica de la Universidad del Zulia por su excelente estudio de la pieza operatoria y por su amable colaboración en la obtención de fotografias y microfotografias.

Fig. 9.—*A*, fotografia del resultado final (cara dorsal del pie afectado). B, fotografia de cara dorsal de ambos pies, notese el relieve venoso en el pie sano.

RESUMEN

Se discute el lugar de la *arteriectomia* en el tratamiento de la enfermedad de Winiwarter-Buerger, puntualizando sus beneficios, derivados de la supresión delos reflejos arterio-arteriales patológicos vasoconstrictores, lo cual provoca una mejoria de la circulación del miembro; se pondera la ventaja de la posibilidad de practicar el exámen anatomo-patológico que daría el diagnóstico preciso.

Se hacen notar los buenos resultados obtenidos por la combinación de la operación de Leriche con la administración de vacuna ani-tifoidea, segun las normas de Wright, y Allen y as.

Se propone, por via de estudio, el tratamiento sistemático de la enfermedad de Winiwarter-Buerger, con la siguiente escala ascendente:

1) arteriectomia y exámen histo-patológico.
2) vacuna anti-tifoidea, ganglioplejicos, infiltración novocaínica, tratamiento sintomático.
3) operación de Diez (gangliectomia lumbar).
4) operación de von Oppel (adrenalectomia).
5) excepcionalmente, amputación.

RÉSUMÉ

Les auteurs discutent le lieu de l'*artériectomie* dans le traitement de la maladie de Buerger, insistant sur ses avantages qui dépendent de la suppression des réflexes vasoconstricteurs artério-artériels, ce que améliore la circulation du membre. Ils mettent en évidence les avantages de l'examen pathologique qui permet un diagnostic définitif.

Les bons résultats obtenus en combinant l'opération de Leriche avec l'administration de vaccin typhoidique comme le conseillent Wright et d'autres auteurs, sont soulignés.

Il est proposé de traiter expérimentalement la maladie de Buerger dans la progression suivante:

1. Artériectomie et examen pathologique.
2. Utilisation du vaccin typhoidique, de ganglioplégiques, d'infiltrations ganglionnaires à la novocaïne, et traitment symptomatique.
3. Opération de Diez (sympathectomie lombaire).
4. Opération de von Oppel (suprarénalectomie).
5. Exceptionnellement, amputation.

RIASSUNTO

Viene discussa l'importanza dell'arteriectomia nella cura del morbo di Buerger, quale metodo sapace di sopprimere i riflessi vasocostrittori vaso-vasali con conseguente miglioramente del circolo dell'arto.

Vengono ricordati anche i buoni risultati ottenuti combinando l'operazione di Leriche con la somministrazione di vaccino tifoide, come suggerito da Wright.

Si propone il seguente schema di cura:

1. Arteriectomia ed esame del pezzo.
2. Impiego del vaccino tifoide, di ganglioplegici, di procaina per infiltrazioni lombari.
3. Operazione di Diez (gangliectomia lombare).
4. Operazione di von Oppel (surrenalectomia).
5. Amputazione (eccezionalmente).

ZUSAMMENFASSUNG

Die Verfasser erörtern die Stellung der *Arterienresektion* in der Behandlung der Winiwarter-Bürgerschen Krankheit und heben den Nutzen der Operation hervor, der auf der Unterdrückung der pathologischen vasokonstriktorischen arteroarteriellen Reflexe beruht. Dies verbessert den Blutkreislauf in der Gliedmasse. Die

Verfasser betonen ferner den Wert histologischer Untersuchung, die zu einer endgültigen Diagnose führt.

Es wird auf die günstigen Ergebnisse einer kombinierten Behandlung mit der Lericheschen Operation und der Verabreichung von Typhusvakzinen, wie von Wright und anderen empfohlen wird, hingewiesen.

Als experimenteller Behandlungsplan der Bürgerschen Krankheit wird das folgende schrittweise Vorgehen vorgeschlagen:

1. Arterienresektion und histologische Untersuchung.
2. Verwendung von Typhusvakzinen, Infiltration der Ganglien mit Novocain, symptomatische Behandlung.
3. Diezsche Operation (Resektion des lumbalen Sympathikus).
4. Von Oppelsche Operation (Resektion der Nebennieren).
5. Amputation in Ausnahmefällen.

SUMARIO

Os autors discutem o lugar da *arteriectomia* no tratamento da doença de Winiwarter-Buerger, salientando seus benefícios, que dependem da supressão dos reflexos vasoconstrictores patológicos arterio-arteriais. Isto melhora a circulação no membro. Salientam também as vantagens do exame patológico, que proporciona um diagnóstico definitivo.

Os bons resultados obtidos combinando-se a operação de Leriche com a administração de vacina tifoidea, conforme é aconselhado por Wright, e outros, são apresentados.

Propõe-se que a doença de Buerger seja experimentalmente tratada em um gradiente, como se segue:

1. Arteriectomia e exame patológico.
2. Uso de vacina tifoidea, gangliopexicos, infiltração ganglionica de procaina, tratamento sintomático.
3. Operaçãode Diez (simpatectomia lombar).
4. Operação de Von Oppel (supprarrenalectomia).
5. Excepcionalmente, amputação.

SUMMARY

In this paper the writers discuss the place of *arteriectomy* in the treatment of Winiwarter-Buerger's disease, emphasizing its benefits depending on the suppression of the arteriol-arterial pathologic vasoconstrictor reflexes which brings a betterment of the limb circulation; they emphasize likewise the advantage of the possibility of performing a pathologic examination which gives a definite diagnosis.

It also deals with the good results obtained in combining the Leriche's operation with the administration of typhoid vaccine, as advised by Wright and by Allen and others.

It is proposed to treat the Buerger's disease in an experimental way, in a gradient as follows:

1) arteriectomy and pathological examination.
2) typhoid vaccine, ganglioplexics, procain ganglionic infiltration, symptomatic treatment.
3) Diez' operation (lumbar sympathectomy).
4) von Oppel's operation (suprarrenalectomy).
5) exceptionally, amputation.

BIBLIOGRAFIA CONSULTADA

Allen y Barker: Enfermedades vasculares periféricas. Buenos Aires: Bernardes, 1952. 1 vol.

Bazy, Huguier, Réboul y Laubry: Techniques des Endarteriectomies, J. de chir. 65:197-210, 1949.

Diez, J.: La Tromboangiitis obliterante. Buenos Aires: El Ateneo, 1934. 1 vol.

Dubost, C.: Les greffes arterielles, Rap. au Congres de Chir. de Lisbonnne, 1953; J. Chir. 12: 304-312, 1953.

Castillo, R.: Contribución al estudio de algunas arteritis. Tesis de Caracas, Bol. Hosp. 52:53-154, 1944.

Ferrand y Elbaz: Le probleme théorique de la surrénalectomie pour arterite chronique, J. de chir. 72:369-385, 1956.

Fontaine, Kim, Nollak y Kieny: Les greffes vasculaires periphériques, J. de chir. 70:713-754, 1954.

Girardi, Rapaport, Bach, etc.: Tromboangiitis, Diagnóstico, Tratamiento, un folleto, Buenos Aires, 1951.

James y Ivins: Surgery of Peripheral Arterial Disease, Surg. Clin. North America 35:1138, 1955.

Judmeier y Roelling: Intraarterial and subcutaneous oxygen in treatment of peripheral arterial diseases, J. Internat. Coll. Surg. 25:18-25, 1956.

Julian: Diagnosis in Arterial Diseases, Surg. Clin. North America 36:177, 1956.

Julian: Surgery of the Sympathetic Nervous System, with Special Reference to Vascular Diseases and Peripheral States, Surg. Clin. North America 34:1182, 1954.

Leriche, R.: La Chirurgie de la douleur. Paris: Masson et Cie, 1937.

Leriche, R., et Stricker, P.: L'arteriectomie dans les arterites obliterantes. Paris: Masson et Cie.

Leriche, R.: Les Thromboses artérielles. Paris: Masson et Cie, 1946. 1 vol.

Lynch: Surgical Procedures in Peripheral Arterial Diseases, Surg. Clin. North America 33:957, 1953.

Martorell, etc.: Tromboangiitis obliterante, J. Soc. Int. Chir. 11:44-46, 1951.

Perez Carreño, M.: Contribución al estudio de las arteropatias periféricas en Venezuela, Gac. Med. de Caracas 52:459-607, 1954.

Pezzuoli, Montorai, etc.: Tentative d'intérpretation de la surrénalectomie dans la thromboangiose. L'hypertrophie surrénalienne "dysharmonique," Presse Med. 64:693-697, 1956.

Réboul: Endarteriectomie, Presse Med. 62:1202, 1954.

Sanchez Vegas, J. J.: Tromboangeitis obliterante, Tesis de Caracas, 1940, 1 foll.

Savy, P.: Traité de Thérapeutique Clinique. Paris: Masson et Cie, 1955. 4 vol. Vol. II, 1948; Vol. IV, 1955.

Silbert, S.: Tromboangiitis obliterans (Buerger): Treatment of 524 Cases by Repeated Injection of Hypertonic Salt Solution, Surg., Gynec. & Obst. 61:214, 1935.

Wright, I. S.: Vascular Diseases in Clinical Practice. Chicago: The Year Book Publishers, 1948. 1 vol.

. . . Much of the work done in nuclear radiation has not been made available to the medical profession in general, and therefore cannot have been exposed to the acid test of widespread clinical observation . . . when the bulk of atomic research is finally dumped into our laps and literature, we physicians will have to assimilate it in the mass rather than piecemeal as we would prefer . . . We must be prepared at all times in the future to see in our offices patients who are walking demonstrations of careless and ignorant exposures to these atomic forces.

I firmly believe that the discovery of nuclear radiation will produce the greatest change in the lives of mankind since the discovery of fire. I believe that the amount of productive atomic and radiation research, and the use to which this research will extend in medicine in the very near future, will far surpass any group of drugs discovered in the past 50 years—and this includes the steroids and antibiotics. I also believe that our historians will refer to the 20th century as the atomic rather than the antibiotic age of medicine.

—Frohman

Editorial

Heroism In Hungary

SEVERAL years ago, foreseeing with tragic clarity the inroads being made by Soviet Communism among the free nations of the world, I felt it incumbent upon me, as Founder and Secretary General of the College and Editor of the *Journal* and the *Bulletin*, to make a positive protest.

For this I was criticized by some. I was told that "peaceful coexistence" with world communism was not only possible but the only thing that could save us from being engulfed altogether. I cannot help wondering, therefore, what my overoptimistic critics will think of the following excerpts from a letter I have just received from Dr. M. Arthur Kline, who is attached to the American Embassy in Vienna and is Secretary of the American Medical Society there. At present, in cooperation with Austrian surgeons of the first eminence, including Profs. Felix Mandl and Leopold Schönbauer, Dr. Kline is all but submerged in Hungarian rescue work. He writes:

"We are in a state of turmoil here. . . . The situation in Hungary is so heartrending as to defy description. I have been on the border several times, delivering medical supplies and receiving convoys of women and children from the diplomatic missions in Budapest. . . . Murder, devastation, misery and rape are being sown throughout the land. The sanctimonious swindle of Russian "coexistence" has been exposed for the myth it has always been. Tragically, millions of Hungarians are now paying a macabre price for revealing the true nature of these Russian barbarians.

"You have every reason to be proud of 'Chapter Austria.' All of us, particularly Profs. Mandl and Schönbauer, are literally tearing ourselves apart to help the Hungarians however we can. I have given all my medical supplies and equipment to the Austrian Red Cross; one day after the revolution started, I brought them personally to the border to assure that they were distributed into the proper hands. Prof. Mandl was magnificent in organizing the distribution of medical supplies to Hungary . . . In my office as I write there are two of the more than thirty Hungarian doctors and surgeons who came to Vienna to obtain medical supplies for their hospital units in Hungary, but have been prevented from returning by Russian troops on the border. These poor colleagues are in a desperate plight, completely cut off from their families and their profession and reduced to the status of refugees in improvised refugee camps . . . I have appealed to our Embassy, but unfortunately there are no funds available, as all direct aid from the United States is turned over to the International Red Cross, which here is unfortunately poorly organized; it would seem that the Communist elements in Hungary are receiving the major portion of those supplies . . . I do hope that eventually we can come up with some sort of direct aid, for these colleagues deserve it."

This, the report of an eye-witness to what is going on in Hungary today, should open the eyes of others who, up to this point, have preferred to keep them closed. As some perspicacious journalist has late-

ly remarked, there is little profit in trying to achieve peaceful coexistence with a man-eating tiger.

As every acquaintance of the College is aware, the position taken in our *Credo* applies to oppressors only, not to their victims. Those who suffer the onslaughts of catastrophe, whether in the course of nature or imposed by the barbarous inhumanity that still exists in humankind are invariably our first consideration. When the people of the Netherlands were overwhelmed by floods, great numbers being left homeless and helpless, we sent some aid immediately. We have participated actively in the sending of CARE packages to many parts ever since this avenue of help was opened. Our sense of the tragic need of the world for aid and understanding, always acute, has been further heightened by the agonizing bulletins still coming in from Hungary. Long before Dr. Kline's letter arrived, the College had acted; a special meeting of the Board of Governors had been called, and an immediate grant in aid of one thousand dollars had been cabled to our colleagues, Drs. Mandl, Schönbauer and Kline and their co-workers, who are indeed "tearing themselves apart" in the effort to alleviate the sufferings of those who thought freedom worth bleeding and dying for. One need not be an American to share this principle, for it is universal, thank God; an inheritance of the Divine that exists in every human soul and, once allowed to rear its head, cannot be destroyed. Those who gave their consent to the Nazis, those who countenanced and still countenance the Communist regime, those who have adhered and catered to despotism through every age of human history, have done so for two reasons only: ignorance and fear.

Fear does strange things to the heart and mind of man. Were it not for fear, it would be incredible that any human being, much less a whole population, could remain in ignorant obedience to tyranny, with the evidence plain before him and the stench of infamy in his nostrils all day long. But add fear—desperate fear, fear for one's life and one's loved ones, fear not only of death but of slow death by torture, physical, mental and spiritual, and this ignorance becomes comprehensible. Why? Because *fear, grown great enough, leaves no room in man's mind for perception of anything else.*

All tyrants and would-be tyrants, from the petty blackmailer in civilian life to the dictator whose lust for power makes him regard his murdered victims as just so much dead meat, are well aware of this fact. If they were not, they could not retain their power as long as they do. They know that if they let in one ray of light there will be revolt, and once that has happened all is lost. Suppose, for example, that the Russians succeed—and they have not yet done so—in quelling the Hungarian rebels altogether. How long will it last? History supplies the answer. A new generation of Hungarians has caught its first glimpse of freedom and found it good. Eventually, therefore, and inevitably, unless man succeeds in destroying man altogether, *Hungary will be free.* Nor will she stand alone, for the stark heroism of her unequal struggle has intoxicated the world. The other Iron Curtain countries are seething with it, as the situation in Poland proves. The Soviet must look to its fences, and build them of stronger barbed wire than ever before, or there will soon be trouble on the home front also. The Russians are human too, as their ridding themselves of the Tsarist yoke has demonstrated. Let them once understand how abysmally they have been fooled, and there will be little more to dread from that direction.

It is this hope—this certainty, rather, if history is to be believed—that has led the College to give its official approval to

President Eisenhower's effort to solve the current problems of the world without resorting to war. All time gained without war is of value to civilization, for once in a long while in the world's history, "in a moment, in the twinkling of an eye," an idea has broken forth that changed the whole course of all mankind. We have faith to believe that, once the Russian people realize what has been done to them, such a moment will occur again, this time on an epic scale.

For let it be clearly understood, above all things, that we are not in enmity with the Russian people except as they lend "their lives, their persons and their sacred honor" to the perpetuation of tyranny. We believe that they do this in ignorance, not knowing what real freedom can mean to a man. When they do know, they will find us their friends.

The fact remains that we cannot batter our way into their lives and tell them. The barriers remain effective, in spite of various sporadic and specious attempts to pretend they have fallen. Indoctrination has been so thoroughgoing that, on the rare occasions when a visitor from one of the free nations has had the opportunity to talk privately with a Russian, his representations of life in a free environment have been met with suspicion, half-hidden derision or frank and open disbelief. In these circumstances there is nothing we can do but wait, with what patience we can summon, for light to break through their darkness, and meanwhile make our voices heard for freedom. If we cannot stand for freedom without decrying its opposite, then we must decry it — openly, continuously and with all the force at our command, hoping that some echo of it will be heard where it will do the most good. The Hungarian tragedy, ghastly and costly as it has been and will be, may prove the turning point toward sanity and peace.

—M.T.

. . . There is a part of the philosophy of medicine that has as yet been little attended to; I mean that which treats of the diseases of the mind, of the influence of affections primarily mental, on the corporeal functions, and particularly of the passions and emotions. Something, I am convinced, might be done on this subject. Every author whom I have read, in treating on it, has immediately exclaimed on its great difficulty, and most of them have asserted that it is impossible that we should ever acquire any knowledge on a business so intricate. But though we may never know *how* mind acts on matter, we may, by careful attention, possibly discover the general principles of this action; which is all, indeed, that we are able to attain in regard to the action of matter on matter.

—Currie

New Books

Books Received.—The following books have been received by the Editor; they will be reviewed critically as space and facilities permit. Omission of more extended review, however, is not to be taken as criticism of the merit of the book.

Ankylosing Spondylitis: Clinical Considerations, Roentgenology, Pathologic Anatomy and Treatment. By J. Forestier, F. Jacqueline and J. Rotes-Querol. Translated by A. U. Desjardins. Springfield, Ill.: Charles C Thomas, Publisher, 1956. Pp. 374, with 145 illustrations.

Tumors of the Skin. By Herbert Conway. Springfield, Ill. Charles C Thomas, Publisher, 1956. Pp. 267, with 178 illustrations, 3 in color.

Handbook of Physical Therapy. By Robert Shestack. New York: Springer Publishing Company, Inc., 1956. Pp. 212.

Traite de Technique Chirurgicale: Appareil Urinaire et Appareil Genital de l'Homme, Tome VIII (Treatise on Surgical Technique: The Male Genitourinary Apparatus, Volume 8). By Bernard Fey, Raymond Dossot and Louis Quénu. Paris: Masson et Cie, 1956. Pp. 870, with 899 illustrations. *Reviewed in this issue.*

Dermatology. By Donald N. Pillsbury, Walter B. Shelley and Albert N. Kligman. Philadelphia: The W. B. Saunders Company, 1956. *Reviewed in this issue.*

New Illustrated Practice of Surgery: Fasciscule IX. Edited by Jean Quenu. Paris: G. Doin et Cie, 1956. Pp. 264, with 227 illustrations.

The Dental Treatment of Maxillofacial Injuries. By William Kelsey Frya and Terence Ward. Springfield, Ill.: Charles C Thomas, Publisher, 1956. 2d ed. Pp. 372, with 383 illustrations. *Reviewed in this issue.*

Head Injuries and Their Management. By Francis Asbury Echlin. Philadelphia: The J. B. Lippincott Company, 1956. Pp. 127, with 10 illustrations.

Neurological Nursing. By John Marshall Sr. Springfield, Ill.: Charles C Thomas, Publisher, 1956. Pp. 166, with 83 illustrations. *Reviewed in this issue.*

The Merck Manual of Diagnosis and Therapy. Rahway, N. J.: Merck & Co., Ltd., Publications Department, 1956. 9th ed. Pp. 1,888.

Surgery in General Practice. By Victor Richards. St. Louis: The C. V. Mosby Company, 1956. Pp. 947, with 476 illustrations.

Fluid Balance Handbook for Practitioners. By William D. Shively Jr. and Michael J. Sweeney. Springfield, Ill.: Charles C Thomas, Publisher, 1956. Pp. 326.

The Biliary Tract. By Julian A. Sterling. Baltimore: Williams and Wilkins, 1956. Pp. 424, with 94 illustrations.

Bronchus und Tuberkulose: Bronchoskopische und Bronchographishe Untersuchungen der Bronchien bei der Tuberkulose (Fortschr. a. d. Geb. d. Röntgenstrahlen, Ergänzungsband 73). By A. Huzly and F. Böhm. Stuttgart: Georg Thieme Verlag, 1955. Distributed in the United States and Canada by the Intercontinental Medical Book Corporation, New York 16, New York. Pp. 138, with 258 illustrations.

Traité de Technique Chirurgicale: Appareil Urinaire et Appareil Genital de l'Homme. Tome VIII (Treatise on Surgical Technique: The Male Genitourinary Apparatus. Vol. 8). By Bernard Fey, Raymond Dossot and Louis Quénu. Paris: Masson et Cie, 1956. Pp. 870, with 899 illustrations.

The *Treatise on Surgical Techniques* consists of eight volumes, the eighth being devoted to operations on the genitourinary tract. The first edition appeared in 1940, and since then such great progress has been made in genitourinary surgery that the authors have rewritten Volume III and brought it up to date.

The first chapter is devoted to general considerations: anatomy, physiology, surgical technic, preoperative preparation, postoperative care, anesthesia and instrumentation.

In advance of any discussion of surgical technic, the anatomic aspects of the particular organ concerned are described in detail at the beginning of each chapter.

The various incisions for exposing the kidney are described. The authors point out that, although the lumbar incision was universally used in the past, other incisions have been devised that afford better exposure in certain instances, e.g., the anterolateral, the retroperitoneal-abdominal, the transperitoneal and the thoracoabdominal (Fey, 1925) approach.

The technics for radical and conservative operations on the kidney are described. A precise technic for nephrectomy via various routes is presented and discussed at length. There is an excellent chapter on nephrectomy for carcinoma, in which the kidney is ablated *en masse*, including the lymphatics. The relatively recent technic for removal of neoplastic implants in the renal vein and vena cava is described. Among the conservative operations, partial nephrectomy is particularly well handled.

The chapter on the many operations for the correction of obstruction of the ureteropelvic juncture is particularly well illustrated. Of great interest is the technic for intervention on the anomalous kidney.

Methods for removal of retroperitoneal tumor and the adrenal gland are presented, including the retroperitoneal, the transperitoneal and the transthoracic approach.

Current operations on the ureter are described, including the recent technic devised by Puigvert for removal of the lower portion of the sclerosed obstructing tuberculous ureter and reimplantation into the bladder.

In dealing with surgical treatment of the bladder, the authors include Darget's denervation technic. The technic for partial and total cystectomy is well illustrated. The most recent operation, creation of a substitute for the bladder, which consists of utilizing a segment of intestine to increase the size of the bladder or re-form it (Couvelaire and Cibert) is a promising procedure.

Prostatic surgical treatment is brought up to date, and suprapubic, retropubic and perineal prostatectomy, as well as transurethral resection, are described.

The surgical management of ruptures of the urethra is well covered. A chapter is devoted to surgical treatment of the female urethra, including various operations for the correction of incontinence.

Operations on the testicle include the radical procedure for carcinoma and anastomosis of the epididymis with the vas deferens.

The text is clearly written and the various operations precisely related in separate paragraphs, which makes the book surprisingly simple to read. The illustrations are all particularly good and enable one to follow each operation step by step. Seldom does one find so many illustrations in a volume on surgical technic. Anyone who wishes to increase his knowledge of genitourinary surgery can well afford the time to read this volume; the clarity of the text and the excellence of the illustrations will facilitate his task and add considerably to his efficiency.

CHARLES PIERRE MATHÉ, M.D.

Neurological Nursing. By John Marshall Sr., Springfield Ill.: Charles C Thomas, Publisher, 1956. Pp. 166, with 83 illustrations.

This monograph is written for the neurologic and neurosurgical nurse but will be of great value to resident physicians on neurologic or neurosurgical services and will be of interest to neurologists, neurosurgeons, physiotherapists and social workers connected with the care of neurologic patients. It is concise, well written and illustrated. American readers will be impressed by the apparent responsibility of nurses in the British Isles for procedures that in this country are usually reserved for physicians. All technical procedures are described in detail, and the book is well illustrated with diagrams and photographs. In illustrations showing the posturing of the prone patient, however, no provision is shown for support of the head, although other details are meticulously illustrated and described.

The care of the unconscious patient and the skin and bladder of the paraplegic patient are especially well covered. Perhaps one of the best features of the work is the emphasis on the proper psychic approach to patients with neurologic disease and the repeated illustrations of the value of proper attitude and approach on the part of the nurse, as well as the scope of the role she may play in the education of the patient.

This book is well worth reading for everyone concerned with the care of the neurologic or neurosurgical patient.

HAROLD C. VORIS, M.D.

The Dental Treatment of Maxillo-Facial Injuries. By William Kelsey Frya and Terence Ward. Springfield, Ill.: Charles C Thomas, Publisher, 1956. 2d ed. Pp. 372, with 383 illustrations.

This book is the second edition, appearing after an original printing in 1942 and a revised edition in 1945. Therefore, it is more complete in many areas such as antibiotics, treatment of complications and the use of bone grafts. Although not voluminous, under 400 pages, the authors have covered the entire field of oral surgery and maxillo-facial injuries. The book is concerned primarily with traumatic conditions and includes chapters such as "pathology of bone repair," and "loss of tissue." It is well written and contains adequate photographs, pictures and diagrams. The book is indexed but does not have a bibliography.

ARNO LESHIN, M.D.

Dermatology. By Donald M. Pillsbury, Walter B. Shelley, and Albert M. Kligman. Philadelphia: The W. B. Saunders Company, 1956.

This is a complete, up-to-the-minute text by three outstanding practitioners from a leading training center for dermatologists. The authors are distinguished investigators in cutaneous medicine, which may account for the volume's vital, dynamic flavor. This notable book marks a new era in dermatologic texts with its iconoclastic attitude toward many outworn shibboleths. The result is fresh and moving. There is no padding with discarded theories and therapy, though this is a large work and fully authoritative. Basic throughout is a broad, fundamental biologic approach. This signifies a platform for easy understanding by general practitioner and specialist. Yet the book is a complete and adequate reference for the experienced dermatologist. The latter may miss listings of pertinent literature; for others this omission makes for easier, uninterrupted reading. Several chapters by contributing authorities are valuable. The printing, binding and other physical aspects help to make the book a distinguished text for biologist, the general physician and the specialist.

THEODORE CORNBLEET, M.D.

Abstracts from Current Literature

The Prevention and Treatment of Ureteral Injuries Following Abdominal Surgery. Conger, K. B., Pennsylvania M. J. 59:563, 1956.

A surgeon who performs a large number of pelvic operations, particularly total hysterectomies, will probably one day find himself confronted with an injured ureter. These injuries are more common than is reported, as surgeons have no enthusiasm for publishing statistics on such complications. Because of the serious problem arising from this type of injury, it is important that every pelvic surgeon be familiar with the details of its prevention and treatment.

Ureteral injuries recognized during the operation should be repaired. There should never be any need to exteriorize a ureter. The splinting tubes used are pushed upward in the ureter to the renal pelvis and downward into the bladder, where the redundant portion is allowed to curl up. This is later recovered cystoscopically and exteriorized.

The surgeon who does a considerable number of pelvic operations can minimize the injury to the ureter by preoperative insertion of ureteral catheters. Knowledge of the principles of diagnosis and treatment of such injuries will result in the salvage of many kidneys that would otherwise be sacrificed.

EDMUND LISSACK, M.D.

Fifty-One Cases of Lung Cancer with Five Year Survival. R. H., and A. Gougas, J. A., J.A.M.A. 161:961, 1956.

The author reports 51 cases of five-year survival after treatment for carcinoma of the lung which represents experience with 845 patients seen between June 1932 and October 1950. Six hundred and seventy patients had histologically verified pulmonary carcinoma, and 234 were treated by surgical resection. Three out of 84 patients survived more than five years, although gross extension of the carcinoma in their cases was apparent. Fourteen of 55 with metastasis to the mediastinal lymph nodes lived five years or more. Thirty-four of 95 patients with neoplasms localized to the lung survived five years. The resection mortality rate was 15 per cent. Forty-three adenomas, benign and malignant, observed during the same period, were excluded from consideration. Age and sex seem to have little bearing on curability, although the five-year survivors were slightly younger and there were six times as many men as women among them. Fourteen per cent of the carcinomas were discovered on survey roentgen study. Cough, hemoptysis, thoracic pain and symptoms suggesting persistent or recurring infection of the respiratory tract were the common initial manifestations. Of the 7 patients with survey-discovered carcinoma, 4 delayed therapy until symptoms appeared. Seventeen of the 51 patients presented objective signs, including wheeze, diminished breath sounds or bronchial breathing and dullness to percussion. Bronchoscopic study in 18 of 46 cases showed a tumor and in 13 of these biopsy was performed. Sputum and bronchial cytologic study revealed carcinoma cells in 13 of 24 patients studied. All of the five-year survivors were treated by pulmonary resection. Not a single cure could be recorded among those treated by roentgen therapy or chemotherapy alone or in combination. Eight lesions were undifferentiated, and 1 was mixed epidermoid and simplex. Three undifferentiated carcinomas contained small foci of epidermoid and simplex patterns; 5 were large cell types. There were 6 adenocarcinomas; 2 well differentiated and 1 poorly differentiated with a simplex cell pattern, and 3 bronchiolar adenocarcinomas. Apparently none of the adenocarcinomas arose from adenomas. There were 36 epidermoid carcinomas, 10 of which were described as grade 3. The right lung was involved in 28 cases and the left in 23. The upper lobe was the site in 29 cases, the lower lobe in 15, and the middle lobe in 1. Six tumors encroached upon the mainstem bronchi. In 26 the carcinomas were peripheral to the main lobar bronchi; in 22

they were located centrally in the main stem or the lobar bronchi. One five-year survivor with epidermoid carcinoma required block resection of the thoracic wall (3 rib segments), together with the upper lobe.

WARREN A. YEMM, M.D.

The Pathology and Prognosis of Mediastinal Tumors. Kunkel, W. M., Pennsylvania M.J. 59:657, 1956.

Mediastinal tumors are of interest to the surgeon, as 20 per cent of primary mediastinal tumors are malignant at the time of operation. Benign tumors may eventually cause symptoms by pressure upon the adjacent organs. Depending upon the location, size and rapidity of growth of the tumor, respiratory distress, Horner's syndrome, hoarseness, pain, symptoms referable to the spinal cord, dysphagia, obstruction of the superior vena cava, and loss of weight, may result. There is danger of superimposed infection with its possible sequelae, such as fistula formation or even fatal mediastinitis.

Knowledge of the location of these tumors is essential to an intelligent preoperative diagnosis, as there is a tendency for the common neoplasms to occupy usual positions. The thyroid tumors occur in the superior and anterior portions of the mediastinum. These are practically all adenomas. If all of the usual substernal goiters are excluded and only those glands that must be removed transthoracically or by splitting the sternum are taken into consideration, the incidence is less than 2 per cent. The prognosis for mediastinal goiter is the same as for other goiters—excellent if the lesion is properly removed.

Thymomas occur also in the anterior and superior portions of the mediastinum, and all must be considered malignant, because there is no histologic basis on which those that metastasize can be distinguished from those that do not. Series have been reported in which 40 per cent of the thymomas have invaded surrounding tissue by the time of operation, while 13.3 per cent are inoperable. If they can be removed, the likelihood of cure approaches 100 per cent.

As regards myasthenia gravis, it has been pointed out that associated thymic involvement is more likely to be hyperplastic if the patient is under 40 and female but more likely to be neoplastic if the patient is male and over 40. Seventy-five per cent of persons with thymomas have myasthenia gravis. Thymectomy appears to be the treatment of choice.

The most common class of tumor in the anterior portion of the mediastinum is the teratoid type, which is divided into the dermoid tumor and the teratoma. About 12.9 per cent of teratoid tumors are malignant. Microscopically there is considerable variation. The dermoid type, usually cystic, is composed only of elements from the ectoderm and the mesoderm; the teratoma, from all three germ layers.

In the lower anterior part of the chest are observed the pericardial cysts. These are harmless, asymptomatic and diagnosed only by routine roentgen examination. They have a one-cell lining of endothelium (which cannot be differentiated from mesothelium), a fibrous wall of loose texture or smooth muscle, very small attachments and practically no blood supply.

The most common tumors of the mediastinum are secondary tumors involving the lymph nodes in the hilar and midmediastinal areas, chiefly carcinomas and lymphomas.

In this discussion, the author limits himself to primary tumors. In this region, bronchogenic cysts occur. They originate as diverticuli of the foregut in the region of the tracheal bud, or at a later stage. They are unilocular, containing clear to mucoid fluid. Microscopically they are composed of any or all of the tissue composing the trachea and bronchi. There are few reports in the literature of malignant change in a bronchogenic cyst. The most likely complication is the possibility of a secondary infection.

The most common tumor in the posterior portion of the mediastinum are neurogenic. A great many of them are attached to the thoracic wall. Others lie against the vertebrae, connecting through the intervertebral foramens with intraspinal components and thus constituting the hourglass or dumbbell neurofibroma. The characteristic histologic observations are: (1) palisading nuclei, (2) interlacing bundles of fibers, (3) small pigmented foci of degen-

eration and (4) foam cells. Sarcomatous changes have been reported in 37 to 41 per cent of neurofibromas. Malignancy is twice as common in tumors of the thoracic wall.

An uncommon tumor of the posterior portion of the mediastinum is enterocyst of the esophagus. This lesion is embryonically and histologically related to both gastroenteric and bronchogenic cysts. From the surgical point of view they often have a common wall with the esophagus, so that complete excision is almost impossible without damage to that structure.

The tumors of local predilection first considered are chondromas, which have their origin from the sternum, the costal cartilages, the costovertebral articulations and the articular surfaces of the intervertebral discs. Histologically benign chondromas often metastasize. They are classified as benign chondromas, benign osteochondromas, malignant chondromas and malignant osteochondromas. The prognosis of chondromatous tumors of the thorax must always be guarded.

Lipomas have been divided into three types: (1) dumbbells, in which the intrathoracic lipoma is continuous with an extrathoracic portion; (2) a type in which the tumor extends into the neck; (3) a type in which the tumor lies entirely within the thoracic cage. It is assumed that they are congenital.

Fibromas of the mediastinum are rare, but they (1) are more likely to undergo sarcomatous than are neurofibromas, (2) cause local symptoms and possibly become dangerous because of pressure effects, and (3) are slow growing, usually becoming manifest after the age of 40.

Other tumors have been reported as occurring in the mediastinum, including tumors of blood vascular origin, endotheliomas, hemangioendotheliomas, cystic hygromas, hamartomas, organized hematomas, myxomas, xanthomas, fibroleiomyomas, parathyroid adenomas, cysts of the azygos lobe, Boeck's sarcoid and echinococcus cysts.

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The Surgical Treatment of Esophageal Stricture. Maclean, L. D., and Wangensteen, O. H., Surg., Gynec. & Obst. 1:5, 1956.

At the time this report was published 18 patients with esophageal stricture had been treated by a surgical procedure designed to decrease acid peptic irritation of the lower portion of the esophagus. Fifteen patients underwent subtotal gastrectomy, and in 3 the repair of a hiatal hernia, accompanied by a Heincke-Mikulicz pyloroplasty, was performed. In all 18 patients complete disappearance or substantial improvement in dysphagia occurred. The period of observation following operation ranged from four months to sixteen years. Gastric resection was carried out in 1 patient with an extensive corrosive stricture of the esophagus, with but slight improvement. An accompanying gastric or duodenal ulcer was observed in 6 patients with acid peptic strictures of the esophagus; hiatal hernia was present in 7 patients, and both duodenal ulcer and hiatal hernia in 1. In 4 patients no concomitant anatomic abnormality was detected. Reestablishment of a fairly normal esophagogram after gastric resection was observed in even the most deformed and strictured esophagi in the follow-up roentgenograms taken over a period of months. The size of the esophagus lumen, as estimated by the size of a dilator that traverses the strictured area, increased noticeably in the immediate and early postoperative period. Preliminary microscopic studies suggest that the depth of the esophageal lesion in cases of acid peptic esophageal stricture involves primarily the superficial layers of the esophageal wall (mucosa and submucosa) as contrasted with the stricture that results from the ingestion of caustic agents in which the entire esophageal wall becomes involved in the fibrotic process. The production of gastric acid frequently is elevated in patients with esophageal stricture. Esophageal resection with intrathoracic or cervical esophagogastrostomy is recommended for stricture due to lye or concentrated acid. Two patients who were incapacitated and not lastingly benefited by dilatation have been restored to full health after resection of the esophageal stricture. Reduction of the stomach's capacity to secrete acid peptic juice, accompanied by provision for ready emptying of the stomach, will minimize, if not eliminate completely, the likelihood of regurgitation of gastric juice into the esophagus.

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